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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

VIII. THE ANTIQUITY OF MAN AND EGYPTOLOGY.

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IN the great ranges of investigation which bear most directly upon the origin of man, there are two in which Science within the last few years has gained final victories.

The significance of these in changing, and ultimately in reversing, one of the greatest currents of theological thought, can hardly be overestimated; not even the tide set in motion by Cusa, Copernicus, and Galileo was so powerful to bring in a new epoch of belief.

The first of these conquests relates to the antiquity of man on the earth.

The fathers of the early Christian Church, receiving all parts of our sacred books as equally inspired, laid little, if any, less stress on the myths, legends, genealogies, and tribal, family, and personal traditions contained in the Old Testament, than upon the most lofty poems, the most instructive apologues, and the most powerful utterances of prophets, psalmists, and apostles. As to the life of man upon our planet, by bringing together indications of elapsing time in the various books of the Bible, early Christian commentators arrived at conclusions varying somewhat, but in the main agreeing. Some, like Origen, Eusebius, Lactantius, Clement of Alexandria, and the great fathers generally of the first three centuries, dwelling especially upon the Septuagint version of the Scriptures, thought that man's creation took place about six thousand years before the Christian era. Strong confirmation of this view was found in a simple piece of

purely theological reasoning: for, just as the seven candlesticks of the Apocalypse were long held to prove the existence of seven planets revolving about the earth, so it was felt that the six days of creation prefigured six thousand years during which the earth in its first form was to endure; and that, as the first Adam came on the sixth day, Christ, the second Adam, had come at the sixth millennial period. Theophilus, Bishop of Antioch, in the second century, clinched this argument with the text, "One day is with the Lord as a thousand years"; hence the view of the early Church, that the world was then in its last period, and that the seventh day—the great millennium—would arrive about the year 1000 of our era. What striking consequences this belief finally produced all scholars of mediæval history know well.

On the other hand, Eusebius and St. Jerome, dwelling more especially upon the Hebrew text, which we are brought up to revere, thought that man's origin took place at a somewhat shorter period before the Christian era; and St. Jerome's overwhelming authority made this the dominant view throughout western Europe during fifteen centuries.

The simplicity of these great fathers as regards chronology is especially reflected from the tables of Eusebius. In these, Moses, Joshua, and Bacchus—Deborah, Orpheus, and the Amazons—Abimelech, the Sphinx, and Œdipus, appear together as personages equally real, and their positions in chronology equally ascertained.

At times great bitterness was aroused between those holding the longer and the shorter chronology, but, after all, the difference between them, as we now see, was trivial; and it may be broadly stated that in the early Church, "always, and everywhere, and by all," it was held as certain, upon the absolute warrant of Scripture, that man was created from four to six thousand years before the Christian era.

To doubt this, and even much less than this, was to risk damnation. St. Augustine insisted that belief in the antipodes and in the longer duration of the earth than six thousand years were deadly heresies, equally hostile to Scripture. Philastrius, the friend of St. Ambrose and St. Augustine, whose fearful catalogue of heresies served as a guide to intolerance throughout the middle ages, condemned with the same holy horror those who expressed doubt as to the orthodox number of years since the beginning of the world, and those who doubted an earthquake to be the literal voice of an angry God, or who questioned the plurality of the heavens, or who gainsaid the statement that God brings out the stars from His treasures and hangs them up in the solid firmament above the earth every night.

About the beginning of the seventh century, Isidore of Seville,

the great theologian of his time, took up the subject. He accepted the dominant view, not only of Hebrew but of all other chronology, without anything like real criticism; the childlike faith and simplicity of his system may be imagined from his summaries which follow. He tells us:

"Joseph lived one hundred and five years. Greece began to cultivate grain.

"The Jews were in slavery in Egypt one hundred and forty-four years. Atlas discovered astrology.

"Joshua ruled for twenty-seven years. Ericthonius yoked horses together.

"Othniel, forty years. Cadmus introduced letters into Greece.

"Deborah, forty years. Apollo discovered the art of medicine and invented the cithara.

"Gideon, forty years. Mercury invented the lyre and gave it to Orpheus."

Reasoning in this general way, Isidore kept well under the longer date; and the great theological authority of southern Europe having thus spoken, the question was virtually at rest throughout Christendom for nearly a hundred years.

Early in the eighth century the Venerable Bede, the great theological authority of the North, took up the problem. Dwelling especially upon the received Hebrew text of the Old Testament, he soon entangled himself in very serious difficulties; but, in spite of the great fathers of the first three centuries, he reduced the antiquity of man on the earth by nearly a thousand years, and, in spite of mutterings against him as coming dangerously near a limit which made the theological argument from six days to six ages look doubtful, his authority had great weight, and did much to fix western Europe in its allegiance to the general system laid down by Eusebius and Jerome.

In the twelfth century this belief was re-enforced by a tide of thought from a very different quarter. Rabbi Moses Maimonides and other Jewish scholars, by careful study of the Hebrew text, arrived at conclusions diminishing the antiquity of man still further, and thus gave strength to the shorter chronology throughout the middle ages: it was incorporated into the sacred science of Christianity; and Vincent de Beauvais, in his great Speculum Historiale, forming part of that still more enormous work which sums up all the knowledge possessed by the ages of faith, placed the creation of man at about four thousand years before our era.*

* For the date of man's creation as given by leading chronologists in various branches of the Church, see L'Art de Vérifier les Dates, Paris, 1819, vol. i, pp. 27 *et seq.* In this edition there are sundry typographical errors; compare with Wallace, True Age of the World, London, 1844. As to preference for the longer computation by the fathers of the Church, see Clinton, Fasti Hellenici, vol. ii, p. 291. For the sacred significance of the six days of

At the Reformation this view was not disturbed. The same manner of accepting the sacred text which led Luther, Melanchthon, and the great Protestant leaders generally, to oppose the Copernican theory, fixed them firmly in this biblical chronology; the key-note was sounded for them by Luther when he said, "We know, on the authority of Moses, that longer ago than six thousand years the world did not exist." Melanchthon, more exact, fixed the creation of man at 3963 B. C.

But the great Christian scholars continued the old endeavor to make the time of man's origin more precise; there seems to have been a sort of fascination in the subject which developed a long array of chronologists, all weighing the minutest indications in our sacred books, until the Protestant divine, De Vignolles, who had given forty years to the study of biblical chronology, declared that he had gathered no less than two hundred computations based upon Scripture, and no two alike.

As to the Roman Church, about 1580 there was published, by authority of Pope Gregory XIII, the Roman Martyrology, and this, both as originally published and as revised in 1640 under Pope Urban VIII, declared that the creation of man took place 5199 years before Christ.

But of all who gave themselves up to these chronological studies, the man who exerted the most powerful influence upon the dominant nations of Christendom was Archbishop Usher. In 1650 he published his Annals of the Ancient and New Testaments, and it at once became the greatest authority for all English-speaking peoples. Usher was a man of deep and wide theological learning, powerful in controversy; and his careful conclusion, after years of the most profound study of the Hebrew Scriptures, was, that man was created 4004 years before the Christian era. His verdict was widely received as final; his dates were inserted in the margins of the authorized version of the English Bible, and were soon practically regarded as equally inspired with the sacred text itself; to question them seriously was to risk preferment in the Church and reputation in the world at large.

The same adhesion to the Hebrew Scriptures which had influenced Usher, brought leading men of the older Church to the same view; men who would have burned each other at the stake for

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creation in ascertaining the antiquity of man, see especially Eicken, Geschichte der mittelalterlichen Weltanschauung; also Wallace, True Age of the World, pp. 2, 3. For the views of St. Augustine, see Topinard, Anthropologie, citing the De Civ. Dei., lib. xvi, c. viii, lib. xii, c. x. For the views of Philastrius, see the De Hæresibus, c. 102, 112, *et passim*, in Migne. For Eusebius's simple credulity, see the tables in Palmer's Egyptian Chronicles, vol. ii, pp. 828, 829. For Bede, see Usher's Chronologia Sacra, cited in Wallace, True Age of the World, p. 35. For Isidore of Seville, see Isidore, Etymologia, lib. v, c. 39; also lib. iii, 617.

their differences on other points, agreed on this: Melanchthon and Tostatus, Lightfoot and Jansen, Salmeron and Scaliger, Petavius and Kepler, inquisitors and reformers, Jesuits and Jansenists, priests and rabbis, stood together in the belief that the creation of man was proved by Scripture to have taken place between 3900 and 4004 years before Christ.

In spite of the severe pressure of this line of authorities, extending from St. Jerome and Eusebius to Usher and Petavius, all in favor of this scriptural chronology, even devoted Christian scholars, had sometimes felt obliged to revolt. The first great source of difficulty was increased knowledge regarding the Egyptian monuments. As far back as the last years of the sixteenth century, Joseph Scaliger had done what he could to lay the foundations of a more scientific treatment of chronology, insisting especially that the historical indications in Persia, in Babylon, and, above all, in Egypt, should be brought to bear on the question. More than that, he had the boldness to urge that the chronological indications of the Hebrew Scriptures should be fully and critically discussed in the light of Egyptian and other records, without any undue bias from theological considerations. His idea may well be called inspired, yet it had little effect as regards a true view of the antiquity of man, even upon himself, for the theological bias prevailed above all his reasonings, even in his own mind. Well does a brilliant modern writer declare that, "among the multitude of strong men in modern times abdicating their reason at the command of their prejudices, Joseph Scaliger is perhaps the most striking example."

Early in the following century Sir Walter Raleigh, in his History of the World (1603–1616), pointed out the danger of adhering to the old system. He, too, foresaw one of the results of modern investigation, stating it in these words, which have the ring of prophetic inspiration: "For in Abraham's time all the then known parts of the world were developed. . . . Egypt had many magnificent cities, . . . and these not built with sticks, but of hewn stone, . . . which magnificence needed a parent of more antiquity than these other men have supposed." In view of these considerations, Raleigh followed the chronology of the Septuagint version, which enabled him to give to the human race a few more years than were usually allowed.

About the middle of the seventeenth century Isaac Vossius, one of the most eminent scholars of Christendom, attempted to bring the prevailing belief into closer accordance with ascertained facts, but save by a chosen few his efforts were rejected. In some parts of Europe a man was by no means safe from bodily harm in holding new views on chronology. As an example of the extreme pressure exerted by the old theological system at times

upon honest scholars, we may take the case of La Peyrère, who, about the middle of the seventeenth century, put forth his book on the Pre-Adamites—an attempt to reconcile sundry well-known difficulties in Scripture by claiming that man existed on earth before the time of Adam. He was taken in hand at once; great theologians rushed forward to attack him from all parts of Europe; within fifty years thirty-six different refutations of his arguments had appeared; the Parliament of Paris burned the book, and the Grand Vicar of the archdiocese of Mechlin threw him into prison and kept him there until he was forced, not only to retract his statements, but to abjure his Protestantism.

But, in spite of warnings like this, we see the new idea cropping out in various parts of Europe. In 1672 Sir John Marsham published a work in which he showed himself bold and honest. After describing the heathen sources of Oriental history, he turns to the Christian writers, and, having used the history of Egypt to show that the great Church authorities were not exact, he ends one important argument with the following words: "Thus the most interesting antiquities of Egypt have been involved in the deepest obscurity by the very interpreters of her chronology, who have jumbled everything up (*qui omnia susque deque permiscuerunt*), so as to make them match with their own reckonings of Hebrew chronology: truly a very bad example, and quite unworthy of religious writers."

This sturdy protest of Sir John against the dominant system and against the "jumbling" by which Eusebius had endeavored to cut down ancient chronology within safe and sound orthodox limits, had little effect. Though eminent chronologists of the eighteenth century, like Jackson, Hales, and Drummond, gave forth multitudes of ponderous volumes pleading for a period somewhat longer than that generally allowed, and insisting that the received Hebrew text was grossly vitiated as regards chronology, even this poor favor was refused them; the great mass of believers found it more comfortable to hold fast the faith committed to them by Usher, and it remained settled that man was created about four thousand years before our era.

This tide of theological reasoning rolled on through the eighteenth century, swollen by the biblical researches of leading commentators, Catholic and Protestant, until it came in great majesty and force into our own nineteenth century; and it was well received. At the very beginning of our century it gained new strength from various great men in the Church, among whom may be especially named Dr. Adam Clarke, who declared that, "to preclude the possibility of a mistake, the unerring Spirit of God directed Moses in the selection of his facts and the ascertaining of his dates."

All opposition to the received view seemed broken down; and as late as 1835, indeed as late as 1850, came an announcement in the work of one of the most eminent Egyptologists, Sir J. G. Wilkinson, to the effect that he had modified the results he had obtained from Egyptian monuments, in order that his chronology might not interfere with the received date of the Deluge of Noah.*

But all investigators were not so docile as Wilkinson, and there soon came a new train of scientific thought which rapidly undermined all this theological chronology. Not to speak of other noted men, we have early in the present century Young, Champollion, and Rosellini, beginning a new epoch in the study of the Egyptian monuments. Nothing could be more cautious than their procedure, but the evidence was soon overwhelming in favor of a vastly longer existence of man in the Nile Valley than could be made to agree with even the longest duration then allowed by theologians.

First of all, in spite of all the suppleness of men like Wilkinson, it became evident that, whatever system of scriptural chronology was adopted, Egypt was the seat of a flourishing civilization at a period before the "Flood of Noah," and that no such flood had ever interrupted it. This was bad, but worse remained behind: it was soon clear that the civilization of Egypt began earlier than the time assigned for the creation of man, even according to the most liberal of the sacred chronologists.

As time went on, this became more and more evident: the long duration assigned to human civilization in the fragments of Manetho, the Egyptian scribe at Thebes in the third century B. C., was discovered to be more accordant with truth than the chronologies of the great theologians; and, as the present century has gone on, scientific results have been reached absolutely fatal to the chronological view based by the universal Church upon Scripture for nearly two thousand years.

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* For Lightfoot, see his Prolegomena relating to the age of the world at the birth of Christ; see also in the edition of his works, London, 1822, vol. iv, pp. 64, 112. For Scaliger, see the De Emendatione Temporum, 1583; also Mark Pattison, Essays, Oxford, 1889, vol. i, pp. 162 *et seq.* For Raleigh's misgivings, see his History of the World, London, 1614, p. 227, Book II of Part I, section 7 of chapter i; also Clinton's Fasti Hellenici, ii, 293. For Usher, see his Annales Vet. et Nov. Test., London, 1650. For Marsham, see his Canon Chronicus Aegyptiacus Ebraicus Graecus et Disquisitiones, London, 1672. For La Peyrère, see especially Quatrefages, in Revue des Deux Mondes for 1861, as cited in Topinard, Anthropologie, p. 52. For Jackson, Hales, and others, see Wallace's True Age of the World. For Wilkinson, see various editions of his work on Egypt. For Vignolles, see Leblois, vol. iii, p. 617. As to the declarations in favor of the recent origin of man, sanctioned by Popes Gregory XIII and Urban VIII, see Strauchius, cited in Wallace, p. 97. For the general agreement of church authorities, as stated, see L'Art de Vérifier les Dates, as above. As to difficulties of scriptural chronology, see Ewald, History of Israel, English translation, London, 1883, pp. 204 *et seq.*

As is well known, the first of the Egyptian kings of whom mention is made upon the monuments of the Nile Valley is Mena, or Menes. Manetho had given a statement, according to which Mena must have lived nearly six thousand years before the Christian era; this was looked upon for a long time as utterly inadmissible, since it was so clearly at variance with the chronology of our own sacred books; but, as time went on, large fragments of the original work of Manetho were more carefully studied and distinguished from corrupt transcriptions, the lists of kings at Karnak, Sacquarah, and the two temples at Abydos were brought to light, and the lists of court architects were discovered. Among all these monuments the scholar who visits Egypt is most impressed by the sculptured tablets giving the lists of kings. Each shows the monarch of the period doing homage to the long line of his ancestors. Each of these sculptured monarchs has near him a tablet bearing his name. That great care was always taken to keep these imposing records correct is certain; the loyalty of subjects, the devotion of priests, and the family pride of kings were all combined in this, and how effective this care was is seen in the fact that kings now known to be usurpers are carefully omitted. The lists of court architects, extending over the period from Seti to Darius, throw a flood of light over the other records.

Comparing, then, all these sources, and applying an average from the lengths of the long series of well-known reigns to the reigns preceding, the most careful and cautious scholars have satisfied themselves that the original fragments of Manetho represent the work of a man honest and well informed, and, after making all allowances for discrepancies and the overlapping of reigns, it has become clear that the period known as the reign of Mena must be fixed at about five thousand years B. C. In this the three great Egyptologists of our time concur; Mariette, the eminent French authority, puts the date at 5004 B. C., and with this the foremost English authority, Sayce, agrees; Brugsch, the leading German authority, puts it at about 4500 B. C. We have it, then, as the result of a century of work by the most acute and trained Egyptologists, and with the inscriptions upon the temples and papyri before them, both of which are now read with as much facility as many mediæval manuscripts, that the reign of Mena must be placed close upon seven thousand years ago.

But the significance of this conclusion can not be fully understood until we bring into connection with it some other facts revealed by the Egyptian monuments.

The first of these is that which struck Sir Walter Raleigh—that, even in the time of the first dynasties in the Nile Valley, a high civilization had already been developed. Take, first, man

himself: we find sculptured upon the early monuments types of the various races—Egyptians, Israelites, negroes, and Libyans—as clearly distinguishable in these paintings and sculptures of from four to six thousand years ago as the same types are at the present day. No one can look at these sculptures upon the Egyptian monuments, or even the fac-similes of them, as given by Lepsius or Prisse d'Avennes, without being convinced that they indicate, even at that remote period, a difference of races so great that long previous ages must have been required to produce it.

Take, next, the social condition of Egypt revealed in these early monuments of art: they force us to the same conclusion. Those earliest monuments show that a very complex society had even then been developed. We not only have a separation between the priestly and military orders, but agriculturists, manufacturers, and traders, with a whole series of subdivisions in each of these classes. The early tombs show us sculptured and painted representations of a daily life which even then had been developed into a vast wealth and variety of grades, forms, and usages.

Take, next, the political and military condition: one fact out of many reveals a policy which must have been the result of long experience. Just as now, at the end of the nineteenth century, the British Government, having found that they can not rely upon the native Egyptians for the protection of the country, are drilling the negroes from the interior of Africa as soldiers, so the celebrated inscription of Prince Una, as far back as the sixth dynasty, speaks of the Maksi or negroes levied and drilled by tens of thousands for the Egyptian army.

Take, next, engineering: here we find very early operations in the way of canals, dikes, and great public edifices, so bold in conception and thorough in execution as to fill our greatest engineers of these days with astonishment. The quarrying, conveyance, cutting, jointing, and polishing of the enormous blocks in the interior of the Great Pyramid alone are the marvel of the foremost stone-workers of our century.

As regards architecture, we find not only the pyramids, which date from the very earliest period of Egyptian history, and which are to this hour the wonder of the world for size, for boldness, for exactness, and for skillful contrivance, but also the temples with long ranges of colossal columns wrought in polished granite, with wonderful beauty of ornamentation, with architraves and roofs vast in size and exquisite in adjustment, which by their proportions tax the imagination, and lead the beholder to ask whether all this can be real.

As to sculpture, we have not only the great Sphinx of Gizeh, so wonderful by its boldness and plastic character, dating from

the very first period of Egyptian history, but we have ranges of sphinxes, heroic statues, and bas-reliefs, showing that even in the early ages this branch of art had reached an amazing development.

As regards the perfection of these, Lübke, the most eminent German authority on plastic art, referring to the early works in the tombs about Memphis, declares that, "as monuments of the period of the fourth dynasty, they are an evidence of the high perfection to which the sculpture of the Egyptians had attained." Brugsch declares that "every artistic production of those early days, whether picture, writing, or sculpture, bears the stamp of the highest perfection in art." Maspero, the most eminent French authority in this field, while expressing his belief that the Sphinx was sculptured even before the time of Mena, declares that "the art which conceived and carved this prodigious statue was a finished art, an art which had attained self-mastery and was sure of its effects"; and Sir James Fergusson, the highest English authority, declares, "We are startled to find Egyptian art nearly as perfect in the oldest periods as in any of the later."

The evidence as to the high development of Egyptian sculpture in the earlier dynasties becomes every day more overwhelming. What exquisite genius the early Egyptian sculptors showed in their lesser statues is known to those who have seen those most precious specimens in the Boulak Museum at Cairo, which were wrought before the conventional type was adopted in obedience to religious considerations.

Take, next, decorative and especially ceramic art: as early as the fourth and fifth dynasties we have vases, cups, and other vessels showing exquisite beauty of outline and a general sense of form equal to Etruscan and Grecian work of the best periods.

Take, next, astronomy: to say nothing of the other evidences of a long development of thought in this field, we may go back to the very earliest period of Egyptian civilization, and we find that the four sides of the Great Pyramid are adjusted to the cardinal points with the utmost precision. "The day of the equinox can be taken by observing the sun set across the face of the pyramid, and the neighboring Arabs adjust their astronomical dates by its shadow."

The same view is confirmed by philologists. To use words of Max Düncker: "The oldest monuments of Egypt, and they are the oldest monuments in the world, exhibit the Egyptian in possession of the art of writing." It is found also by the inscriptions of the early dynasties that the Egyptian language had even at that early time been developed in all essential particulars to the highest point it ever attained. What long periods it must have required for such a development every scholar in philology can imagine.

As regards medical science, we have the Berlin papyrus, which, although of a later period, refers with careful specification to a medical literature of the first dynasty.

So, too, as regards archæology: the earliest known inscriptions point to still earlier events and buildings, indicating a long sequence of previous events.

And, finally, as to all that pertains to the history of civilization, no man of fair and open mind can go into the museums of Boulak or the Louvre or the British Museum and look at the monuments of those earlier dynasties without seeing in them the results of a development in art, science, laws, customs, and language, which must have required a vast period before the time of Mena for their development. And this conclusion is forced upon us all the more invincibly when we consider the slow growth of ideas in the earlier stages of civilization as compared with the later—a slowness of growth which has kept the natives in many parts of the world in that earliest civilization to this hour. To this we must add the fact that Egyptian civilization was especially immobile; its development into castes is but one among many evidences that it was the very opposite of a civilization developed rapidly.

As to the length of the period before the time of Mena, there is, of course, nothing exact. Manetho gives lists of great personages before that first dynasty extending over twenty-four thousand years. Bunsen, one of the most learned of Christian scholars, declares that not less than ten thousand years were necessary for the development of civilization up to the point where we find it in Mena's time. No one can claim precision for either of these statements, but they are valuable as showing the impression of vast antiquity made upon the most competent judges by the careful study of those remains. No unbiased judge can doubt that an immensely long period of years must have been required for the development of civilization up to the state in which we there find it.

The investigations in the bed of the Nile confirm these views. That some unwarranted conclusions have at times been announced is true; but the fact remains that again and again rude pottery and other evidences of early stages of civilization have been found in borings at places so distant from each other, and at depths so great, that for such a range of concurring facts, considered in connection with the rate of earthy deposit by the Nile, there is no adequate explanation save the existence of man in that valley thousands on thousands of years before the longest time admitted by our sacred chronologists.

Nor have these investigations been of a careless character. Between the years 1851 and 1854, Mr. Horner, an extremely cautious

English geologist, sank ninety-six shafts in four rows at intervals of eight English miles, at right angles to the Nile, in the neighborhood of Memphis. From these pottery was brought up from various depths, and beneath the statue of Rameses II at Memphis at a depth of thirty-nine feet. At the rate of the Nile deposit a careful estimate has declared this to indicate a period of over eleven thousand years. As eminent a German authority in geography as Peschel characterizes objections to such deductions as groundless. However this may be, the general results of these investigations, taken in connection with the other results of research, are most convincing.

And, finally, as if to make assurance doubly sure, a series of archæologists of the highest standing, French, German, English, and American, have within the past twenty years discovered relics of a savage period, of vastly earlier date than the time of Mena, prevailing throughout Egypt. These relics have been discovered in various parts of the country, from Cairo to Luxor, in great numbers. They are the same sort of prehistoric implements which prove to us the early existence of man in so many other parts of the world at a geological period so remote that the figures given by our sacred chronologists are but trivial. The last and most convincing of these discoveries, that of flint implements in the drift, far down below the tombs of early kings at Thebes, will be referred to later. What such discoveries prove, we shall consider in the next chapter.*

* As to Manetho, see for a very full account of his relations to other chronologists, Palmer, "Egyptian Chronicles," vol. i, chap. ii. For a more recent and readable account, see Brugsch, Egypt under the Pharaohs, English edition, London, 1879, chap. iv. For lists of kings at Abydos and elsewhere, also the lists of architects, see Brugsch, Palmer, Mariette, and others; also illustrations in Lepsius. For the various race types given on early monuments, see the colored engravings in Lepsius, Denkmäler; also Prisse d'Avennes, and the frontispiece in the English edition of Brugsch; see also statement regarding the same subject in Tylor, Anthropology, chap. i. For the fullness of development in Egyptian civilization in the earliest dynasties, see Rawlinson's Egypt, London, 1881, chap. xiii; also Brugsch and other works cited. For the perfection of Egyptian engineering, I rely not merely upon my own observation, but on what is far more important, the testimony of my friend the Hon. J. G. Batterson, probably the largest and most experienced worker in granite in the United States, who acknowledges, from personal observation, that the early Egyptian work is, in boldness and perfection, far beyond anything known since, and a source of perpetual wonder to him. As to the perfection of Egyptian architecture, see very striking statements in Fergusson, History of Architecture, Book I, chap. i. As to the pyramids, showing a very high grade of culture already reached under the earliest dynasties, see Lübke, "Ges. der Arch.," Book I. As to sculpture, see for representations photographs published by the Boulak Museum, and such works as the Description de l'Égypte, Lepsius's Denkmäler, and Prisse d'Avennes; see also as a most valuable small work, easy of access, Maspero, Archæology, translated by Miss A. B. Edwards, New York and London, 1887, chaps. i and ii. See especially in Prisse, vol. ii, the statue of Chafré the Scribe, and the group of "Tea" and his wife. As to the artistic value of the Sphinx, see Maspero, as above, pp. 202, 203. See also similar ideas in Lübke's History of Sculpt-

GLASS-MAKING.

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IV.—IN THE ATELIER OF A GLASS-WORKER.

THERE are few objects of manufacture which better than glass illustrate the immense preponderance in value of human labor over crude material. It is a substance which might serve economists as a parallel to their favorite illustration of the comparative values of a steel watch-spring and the bit of iron-bearing earth from which it is wrought.

In the case of glass, the crude materials are so plentifully distributed in nature as to be almost valueless. The basis of the compound, sand, is so very abundant that it has furnished the symbol, in more than one parable, for quantity without limit. Like the unnumbered sands of the sea was a vast promise to the children of men. Somewhat less abundant than the sand are the other chemicals which it is necessary to mix with it in order to produce that double silicate which goes under the general name of glass. They are, however, far from being either scarce or expensive. The alkaline ingredient, the carbonate of soda, is made from common salt, a mineral whose wide distribution in nature is at once apparent when one recalls the fact that the sea, thirty or forty times in bulk the total elevated mass of the earth, is one vast storehouse of the substance; that salt springs or brines abound at our very doors—in New York State, in Michigan, and in Virginia; and that vast deposits of the solid rock-salt are to be found in Louisiana and Prussia. The third ingredient, the lime, is simply calcined limestone, a rock which forms whole ranges of hills, and is found in every corner of the globe. For the production of the fine flint glass, or crystal, which forms the special subject of the glass-worker's skill, it is also necessary to add a fourth ingredient, red lead or minium. As this is the oxide of an easily

ure, vol. i, p. 24. As to astronomical knowledge evidenced by the Great Pyramid, see Tylor, as above, p. 21. For delineations of vases, etc., showing Grecian proportion and beauty of form under the fourth and fifth dynasties, see Prisse, vol. ii, Art Industriel. As to the philological question, and the development of language in Egypt, with the hieroglyphic system of writing, see Rawlinson's Egypt, London, 1881, chap. xiii; also Le Normant; also Max Düncker, Geschichte des Alterthums, Abbot's translation, 1877. As to the medical papyrus of Berlin, see Brugsch, vol. i, p. 58, but especially the Papyrus Ebers. As to the corruption of later copies of Manetho and fidelity of originals as attested by the monuments, see Brugsch, chap. iv. As to the accuracy of the present Egyptian chronology as regards long periods, see ibid., vol. i, chap. xxxii. As to the pottery found deep in the Nile and the value of Horner's discovery, see Peschel, Races of Man, New York, 1876, pp. 42–44. For succinct statement, see also Laing, Problems of the Future, p. 94.

reducible and useful metal, it is naturally considerably more expensive than the earthy ingredients, but its cost is still far within the limits of moderation. The Rocky Mountains and the Mississippi Valley furnish lead ores in such abundance that the compounds of the metal may fairly be classed among cheap products.

The total cost of the "batch" can not be more than a few cents a pound. Compare this with the value of the finished products. The finer cut glass will sell for perhaps as many dollars a pound, while the finest cameo glass may bring almost as many hundred. It must not be supposed, however, that the difference, or even the

FIG. 1.—THE GLASS-CUTTER AT HIS WHEEL.

greater part of it, goes into the pocket of the manufacturer. A fair proportion reaches that destination, but by far the larger share goes for meat and bread and coal, houses and cloth, to sustain the life of the army of men, women, and children by whose labor these dull earths and oxides are transformed into the brilliant carafes and bowls which adorn our dinner-tables.

Much the greater part of this increased value is conferred upon the glass by the dexterous hand-work expended in the atelier, rather than by the coarser operations which attend the furnace process. This, however, is the basis of all that follows, and the beginnings of the finest cut-glass bowl or cameo vase are to be sought in the mixing-room, where the crude materials are put together. In different establishments the proportions vary, as in the manufacture of all other forms of glass products, and even in the same establishment uniformity is far from absolute.

Although glass is supposed to be a fairly definite chemical compound, each manufacturer has his own notions on the subject, and occasionally he changes his mind, or perhaps his supplies come from a different locality. The result, in either case, would be a slight change in the composition of the batch. A typical mixture would be for every hundred parts of fine white sand about forty parts of alkali (carbonate of soda), ten parts of burned lime, and forty parts of red lead.

It will be noticed that the batch is essentially different from that used in the manufacture of window and of bottle glass. It differs both in the character and the quality of the materials employed. The ingredients common to the several mixtures must be much purer for use in the production of table and household glassware of the finer grades. Care is taken that the sand shall contain no iron; and, in order to free it from any admixture of loam or other disadvantageous earthy materials, it is subjected to a washing process before it is brought to the mixing-room. By this treatment the more finely divided matter, such as clay and the like, is carried off with the water, while the coarser sand settles to the bottom of the washing-troughs. Further, in the selection of the alkali, the cheaper sulphate of soda is never substituted for the carbonate, as is frequently done in the manufacture of bottles.

In the processes of the atelier the competition is a question of quality rather than of quantity. The element of human labor is so large that it would not be economical to expend it upon an inferior grade of glass. The workers, or rather the men who direct them, go on the principle of those wise domestic economists who reflect that the cost of labor in making up clothing is approximately constant, and who therefore do not feel that they can afford to buy shoddy.

The earthy materials—sand, alkali, and lime—give substance and transparency. Fused together, they form ordinary glass. The additional ingredient, the red lead, has a special function to perform. It has for its immediate object an increase in the weight of the glass; and since in general an increase in weight means an increase in refracting power, its ultimate object is an additional brilliancy in the product. Every one has noticed the heaviness of cut glass; or, if he has not, and enters a shop to buy a piece of it, the shop-keeper is very apt to call his attention to the fact—particularly if the price be correspondingly heavy—assuming that weight is an undeniable guarantee of quality and brilliancy. If you object to the price, he puts the piece into your hands and says confidingly, "Just feel the weight of it!" The argument is a pertinent one, but not altogether conclusive, for there are many other elements besides weight upon which the merit of the product depends. It is quite possible to have the glass too heavy for

beauty, since the dense lead compounds have a tendency to separate from the lighter silicates, and, consequently, if present in too large amounts, they make the glass streaky and mottled. In general, lead glass for domestic uses has a specific gravity of from three to four—that is, it is from three to four times as heavy as an equal bulk of water. The brilliancy given to the glass by its increased density has attached the name crystal to this particular product.

It is essential that the several ingredients should be thoroughly mixed, and to this end the operation is carried out mechanically. The materials are fed into the upper end of a slowly revolving hopper, whose axis is slightly inclined to the horizontal, and are thoroughly mixed by the time they reach the discharging end. A dainty pink powder falls into the receiving bins. Its subsequent baptism by fire transforms the opaque into the transparent. The furnaces employed for this purpose are of the type common to other glass-melting processes—simply a circular and intensely heated chamber, surmounted by a stack, and provided with radial openings to permit the blowers to dip their blowpipes into the molten contents of the fire-clay crucible-pots.

FIG. 2.—THE PROCESS OF ENGRAVING ON GLASS.

The scene around this industrial caldron is quite as busy as that which has its center in the bottle furnace, and is even more varied. The workers are fashioning objects of the most diverse shape and for the most unlike purposes. Some are blowing lamp-chimneys, others gaslight globes, or decanters or dishes. In the center of the apartment a large press, with engraved steel dies, is squeezing the plastic "metal"—for so the glass-blower designates his still fluid glass—into decorative panels for car-windows and transoms. As one passes from one end of the large room to the other, he will see almost every conceivable shape in glass, suited

for table or other domestic usage, taking form in the hands of the adroit workers. It is the scene of an intense and a highly ingenious activity. The bottles and dishes and globes intended for subsequent treatment in the atelier are all blown, the manipulations being varied in accordance with the special form it is desired to produce. As a rule, it may be said that it is cheaper to produce the pressed glass than the blown, since less time is required in fashioning the articles; but for the finer work the blown is always preferred, as glass worked exclusively in the air has a much more brilliant surface than that which has been formed in contact with the faces of the iron mold. The plain articles thus shaped are known in the trade as "blanks." The largest manufacturers of cut and engraved glass also make their own blanks, but there are a number of establishments which confine themselves exclusively to the processes of ornamentation. The articles intended for such decoration go from the blower to the annealing leer, where they are permitted to pass through a chamber of brick-work some sixty to eighty feet long, subjected to a gradually decreasing temperature for a period of twenty-four hours or less, according to the circumstances of the work. The articles to be annealed are placed in wrought-iron cars, and are slowly moved through the leer, coming out perfectly cold.

FIG. 3.—THE OPERATION OF MAKING GROUND GLASS GLOBES.

It is in this way that the blanks are prepared for the atelier proper. Here one finds a number of very interesting operations going on side by side. The untechnical visitor will perhaps be most attracted by the cutting process, since the results are so brilliant, and the articles possess so staple a value. He will get a good insight into the general principles by following the process of cutting a carafe.

The blank itself is perfectly plain—a simple, heavy bottle with smooth surface. Its proportions are good. The decoration is to consist of a twenty-four-pointed star on the bottom, a series of more or less complicated diagonal cuttings on the bulging sides, and six or eight broad facets around the neck. To these may be added a number of features of less prominence, such as a series of oval facets around the base of the carafe, and some smaller cuttings at the top. It is the glass-worker's custom to begin with the star on the bottom. This is cut entirely by the eye, no design being traced on the glass. The first process is known technically as "roughing" it, and consists in cutting the design in the glass with coarse tools, which leave rough facets, but remove most of the glass to be cut away. The roughing-wheel is made of iron, and is about two feet in diameter. It is mounted on a horizonal axis. The face of the wheel is about seven eighths of an inch broad, and is kept supplied with a mixture of coarse sand and water allowed to constantly drip upon it from a hopper above. The wheel makes about a thousand revolutions a minute, the speed varying with the character of the work to be done. It is slower for the deeper cuttings. The workman seizes the carafe with both hands, and presses the bottom firmly against the edge of the rotating wheel, making a cut across the center, and as far each way as it is desired to have the star extend. Then he turns the carafe around one sixth of a revolution, and makes a similar cut through the center, judging of the distance entirely by his eye. A second turn of one sixth of a revolution, and a third cut along a diameter is made. This gives a six-pointed star. The intervening spaces are then divided by similar cuts, and the spaces thus formed again divided, giving a twenty-four-pointed star.

A tyro in the art would make a very poor figure of it, but the regular cutters become exceedingly expert, and are able to make comparatively perfect designs in this seemingly off-hand fashion. A trained eye will, of course, have no difficulty in detecting inaccuracies, but the designs are symmetrical enough for all purposes of decoration.

The cutting does not yet possess much beauty, for its faces are as rough as ground glass. Already, however, it begins to show the promise of what it is to be. In treating the bulging sides of the carafe, greater difficulties present themselves in disposing the pattern symmetrically. It is, therefore, the custom to paint a number of guiding lines on the surface of the glass. A few circular lines surrounding the carafe, and a few up-and-down lines afford a series of intersections which are sufficient to enable the cutter to develop a uniform pattern. In the same way the facets surrounding the neck are determined by a couple of limiting cir-

cles, and similarly with the secondary part of the decoration. This completes the rough work.

The second process is that of "smoothing," and is carried out by means of wheels made of a natural stone found in Scotland, known as the Craig Leigh stone. A large part of modern Edinburgh is built out of this material. It is a compact silicious stone, wearing very uniformly, and almost free from that tendency to crumble which characterizes the majority of our native sandstones. The stone wheels are about the same size as the iron wheels used in the roughing process; but their cutting edges, instead of being smooth, are beveled, thus giving a sharp edge in the center of the face. This is occasionally sharpened by regrinding, or by holding pieces of flint against the beveled faces of the revolving wheel. A tiny stream of water falls constantly against the face of the stone. Each cut made on the iron wheel is gone over on the stone, and, by the finer friction, the surface of the facets becomes smooth and transparent. The carafe is slowly becoming an object of beauty.

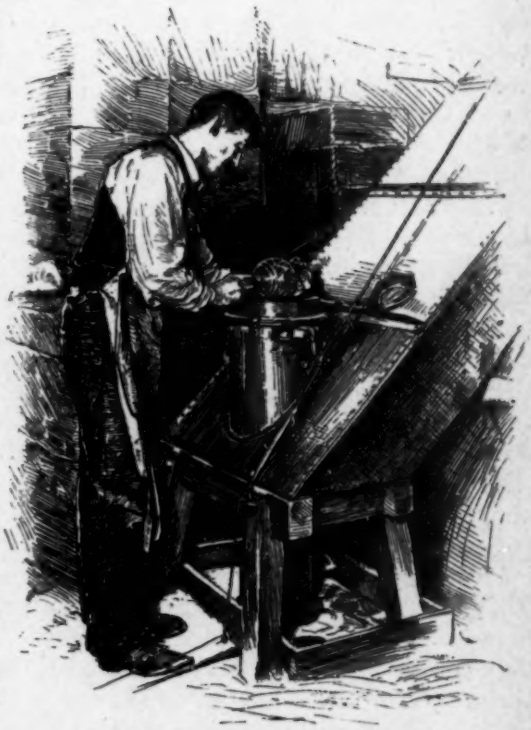

Fig. 4.—The Sand-Blast in Operation.

Next in the order of the processes comes the polishing, which is effected by wooden wheels mounted as before and supplied with pumice or rotten-stone. Red willow is considered the best material for the polishing-wheel, though poplar is also frequently used. The hard woods are found to be less suitable for the purpose. The wooding—for so this third process is called in the atelier—gives a fine finish to the smoothed facets and adds greatly to their brilliancy. It is a process, however, which is only practicable in cases where the cutting is rather deep. Where it amounts to little more than a tracing, the wooden wheel would be of slight use.

Still a fourth process is required before the carafe is ready to

be washed and placed on sale. It is that of brushing. The brush is made of spun glass, and is applied in the form of a wheel as a burnisher. Those who have seen gilt used in china-painting will recall the pencils of spun glass with which the gilding is burnished after being fired. The rapidly revolving brush of glass cleans out the cuttings more perfectly than could be done in any other way, and adds the final luster to the facets. The carafe is now completed. Other articles are cut in much the same way, slight modifications being made to suit different shapes and patterns.

At the present time very good copies of cut-glass articles are made in pressed goods, and at about one twentieth of the cost; but the difference between the two products can readily be detected. Not only are the pressed goods less brilliant, but the edges of their facets are visibly rounded from the fusion, and fail to give the sharp, clear faces of the genuine cut glass. One can tell the fine article at once by simply rubbing his finger over the cutting. The sharp edges of the genuine article are unmistakable. Another attempt to combine beauty and economy is made by cutting some prominent feature of a pressed-glass article, and letting the brilliancy thus obtained make amends for the duller facets of the less exposed portions. In this way pressed-glass decanters are made quite presentable by being supplied with well-cut stoppers, and covered dishes pass muster through the merit of their brilliant knobs. Still another device is that of grinding off the faces of pressed-glass goods, and thus securing, as the result of a much cheaper process, the sharp edges and well-polished faces of the real cut glass. The process, however, is not a very successful one. It sounds better than it works out in practice. Wares treated in this way have the serious defect of lacking brilliancy when compared to the air-blown glass and entire cutting. They are now made in but small quantity, for they can not compete in public estimation with the ordinary pressed goods, since they cost about five times as much, and are far from being five times as effective.

In the most artistic circles there is at present a slight reaction against cut glass in favor of the light and graceful articles made in blown glass. But meanwhile the sale of cut glass grows larger each year, for the improvements in the method of production bring it within reach of an increasingly wide circle of buyers. It promises to remain a standard article of manufacture, for its brilliancy will always attract admirers, and any disappearance will be but temporary. The old-fashioned chandeliers and candelabra, made with pendants of cut glass, are pushed out of the market by newer metallic goods, only to periodically reappear from their obscurity.

Alongside of the cutter's wheel one sees a corner of the atelier devoted to a species of cutting in miniature, which goes under the name of engraving. The cutting instrument is a small copper disk, sometimes as tiny as a dentist's tool, and sometimes several inches in diameter. It is mounted with its axis horizontal, and is made to rotate very rapidly. The cutting is done under-

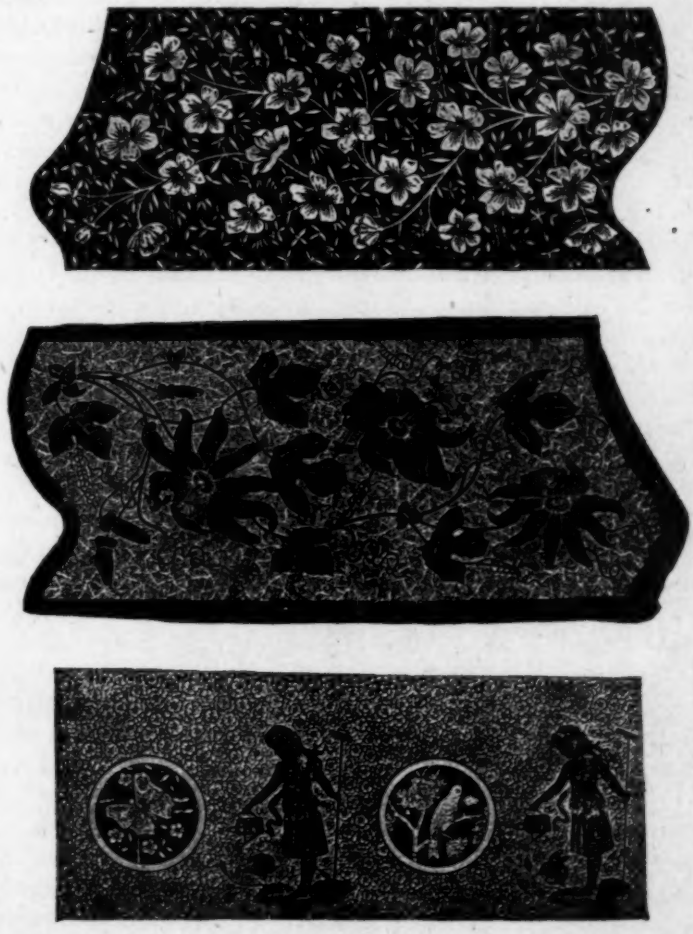

FIG. 5.—THE PRINTED DESIGNS, READY FOR TRANSFERENCE TO THE GLASS, IN THE ETCHING PROCESS.

hand, instead of overhand, as in the former operation, which means, in the language of the outside world, that the article to be engraved is brought into contact with the rotating disk from beneath, instead of being pressed against its upper surface. The disk is supplied with a mixture of emery and oil. This is the real cutting agent; the disk simply applies it. In almost all cases the work is done solely by the eye, without any guiding lines what-

ever. Frequently the engraver originates his pattern as he goes along—a species of improvising which is quite full of interest to an on-looker. In time the men become very skillful in this sort of work, and are quite ready in thinking out new designs. It is entirely a matter of experience, the work depending largely on a nice sense of touch, since the glass is for the most part obscured by the spattered emery and oil. In this way geometric designs of considerable complication, wreaths and flowers, birds, fishes, and dragons, are traced on goblets and other table-ware, as well as on globes and similar articles. It is also the process by which initials and monograms are cut on glass, and its frequent application for this purpose is familiar to every one who is not near-sighted.

The tracery is accomplished sooner than one would fancy. As a rule, it is used in connection with some other form of ornamentation. Frequently in the case of globes there is a light tracery around the central portion, and plain bands at the top and bottom. These are put on very expeditiously, and, consequently, at little cost. The process is known technically as "obscuring." The globes are mounted on a lathe over a sand-box, being fastened between plates of cork in order that they shall not be fractured by the jar. The workman presses a bundle of soft, annealed iron wire against the surface of the quickly rotating globe, and, almost in less time than it takes one to tell about it, the band is completed. The band at the other end of the globe is put on in the same way. If two parallel bands are to be put on near together, the bundle of wire is in two parts, and both bands are made at the same time. The wires simply determine where the obscuring shall be. The real grinding is done by the sand and water with which the surface of the globe is kept constantly supplied. By using a larger bundle of wire, and passing it over the entire surface of the globe, the obscuring is made complete, and we have the so-called ground-glass globe.

The obscuring process is used in connection with both cutting and engraving, a design frequently being brought out much more beautifully by reason of the obscured or translucent background. In this case, however, the cut pattern must not be subjected to the final brushing process, for the glass brush would smooth the obscured surface and give it the almost transparent character displayed by ground glass when moistened with oil or water. The effect would be to make the portion of the glass around the cutting look constantly wet—an undesirable form of decoration. Some of the most pleasing designs are thus produced by a combination of two or more processes. However fully and artistically a plain glass globe may be decorated, there is apt to be an unpleasant effect of thinness of design from the unrestricted pas-

sage of the light through the transparent portions. But by obscuring the entire surface of the globe, and then cutting even a very modest design upon the background so prepared, the result is much more effective. The transmitted light, from its subdued character, is also more agreeable. The cutting is done in the so-called "mud-box"—a designation which has arisen from the fact that the spent sand or mud from the cutting of heavier articles is here utilized.

FIG. 6.—PRINTING THE DESIGNS AND WRAPPING THE GLOBES, PRIOR TO THE ETCHING.

These processes are all purely mechanical. They depend upon the direct friction between the glass and the abrading powder, or between the glass and the cutting stone, as in the case of the smoothing process. It is possible, however, to bring about this grinding action by less direct pressure. One of these indirect methods—the sand-blast—deserves particular mention, both because of its commercial importance and because of its ingenuity. Some years ago there was published a book which pointed out, with more or less cunning, a prototype in nature for nearly all our mechanical devices. The author did not, I believe, mention the sand-blast, but he might well have done so, for it is a direct imitation, though perhaps an unconscious one, of a process which Nature has been using very effectively ever since the first blast of wind carried the earliest sand-grains against the Eozoic rocks. This natural sand-blast has done not a little in altering the appearance of the face of the earth. In the Rocky Mountains there are many curiously sculptured rocks in the comparatively rainless districts, which owe their carving almost entirely to this

agency. Still more striking, perhaps, has been the effect of blowing sand upon the monuments of antiquity. Those who have seen the Obelisk, in Central Park, New York, or have read descriptions of it, will probably recall the fact that on those sides which were originally exposed to the desert wind the hieroglyphics have been entirely worn off by the grinding action of centuries of blowing sand. The action is precisely the same in the atelier, except as to the matter of time. A strong blast of air, charged with particles of sharp, clean sand, will obscure a plain glass surface in the course of a few seconds. It is applied very ingeniously. The design to be traced on the glass is cut out of soft rubber, and the stencil thus formed is held firmly against the surface. The blast of sand-carrying air is secured by means of an exhaust, and is so arranged that it may be made to enter a sheet-iron box placed so that its upper surface shall be at about the level of an ordinary table. There is a round opening in the top of the box, somewhat larger than the pattern to be ground, but not so large as the sheet of rubber in which it is cut. Glass and rubber are then pressed against the opening, and, by means of a pedal, the blast is turned on. In a very short time, scarcely more than five or ten seconds, the blast is turned off, and the stenciled pattern is found ground on the glass. So quickly does the blast do its work that the capacity of the machine may be said to be limited only by the speed with which the operator can adjust things.

FIG. 7.—THE PROCESS OF ETCHING.

The action of the blast is rather interesting. The soft-rubber stencils will endure many exposures, while the hard flint glass is perceptibly worn away in a few seconds. The reason of this is

that the little particle of moving sand can not be brought to rest immediately. However quickly its flight is arrested, there is an appreciable interval of time during which its motion must be parted with. Striking against the soft and flexible rubber, the sand is brought to rest gradually, for the rubber is sufficiently depressed by the Lilliputian blow to dispose of the motion stored up in the particle. When, however, the sand strikes against the hard and rigid glass, there is no giving way possible. The grains must either stop instantly or else they must penetrate between the molecules of the glass. In the latter case they would naturally detach little fragments in sufficient number to roughen the surface of the glass and make it translucent. Experience shows that this is precisely what happens. If the naked hand be held over the blast, a pricking sensation is felt, but the skin is not broken; it is too pliable. Thin sheet-iron stencils are sometimes substituted for those of rubber; their elasticity makes them fairly durable.

The sand-blast was invented by an American, but, as the original patent has expired, any one is at liberty to use the machine. The inventor has since made a number of modifications and improvements, which are protected by subsequent patents. The newer form is used, I believe, more in England than in this country—not so much from a failure on our part to appreciate its merits, as from a dislike of the peculiar royalty arrangements. The machines are sold, and a certain royalty charged each week, whether the works are running or not. As such an arrangement makes the expense a constant quantity, while the income is a variable, it is not acceptable to the majority of American glass-workers.

Other agents besides mechanical find employment in the atelier. One of the properties of glass which makes it most highly esteemed, in both the household and the laboratory, is its almost total indifference at ordinary temperatures to acids and other corrosive chemicals. It is slightly acted upon by the strongest sulphuric acid and by steam under great pressure, but only after the lapse of considerable time. There are few substances, however, which are not, Achilles-like, vulnerable in some one particular. In the case of glass, the effective solvent is the comparatively rare compound, hydrofluoric acid. It is not strange, therefore, that in the numerous manipulations to which glass is subjected this fact should be utilized. It forms the basis of the one chemical process of the atelier, that of etching. It is a process readily and cheaply carried out, and from its effectiveness it is one of increasing importance. The piece of glassware to be treated is protected, in those parts which it is desired shall not be acted upon by the acid, by some substance indifferent to it, such as wax, paraffin, or a

specially prepared ink. The parts not coated are thus the only ones exposed when the piece is plunged into the bath of hydrofluoric acid. They are soon bitten by the acid, and in this way the design is traced upon the glass. As globes for lamps and gas are the subjects most frequently chosen for this treatment, the process can, perhaps, best be understood by following such an article through the several stages of its decorative development. The designs are adapted from a variety of sources. The draughtsman is supplied with drawing-books containing examples of conventionalized flowers. From this unit he works out a design of proper size and shape—that is, something which when wrapped around the globe shall cover just one half of it, and so, by repetition, the whole. He traces his designs on a panel of heavy plate

FIG. 8.—FOUR STAGES: To the right, the plain ground globe; then the globe wrapped in printed paper; next, the printed globe, with the paper removed; and finally, to the left, the finished product.

glass. The surface is coated with a special ink made of lampblack, rosin, and wax, and the design then picked out by means of a sharp tool. The plate, thus prepared, is subjected to the action of a strongly acid bath of hydrofluoric acid for a period of from fifteen to twenty minutes. The uncovered parts of the plate are deeply eaten away. The ink is then washed off, and the plate is ready to print from. Frequently designs are etched on both sides of the panel, both for economy of material and of storage.

The printing is done on a simple engraver's press, the impressions being taken upon smooth, white paper, somewhat heavier than tissue. As the ink used for the purpose has a decided tend-

ency to become stiff and unmanageable in the cold, a gas-flame is kept constantly burning under the engraving plate. The sheets of paper as they come from the press are covered with a thick layer of ink in those portions which correspond to the parts of the globe not to be etched. While still fresh, the printed sheets are passed to a girl sitting at a neighboring table. She cuts off the superfluous paper surrounding the design, and wraps the print around the globe to be treated. A second print serves to cover the globe completely. The paper is pressed tightly against the glass, and the wrapped-up globe then warmed over a gas-stove for a few moments. The paper is left on for a day or so, and when it is finally removed the design is found transferred to the glass. It will be seen that the process is not unlike that by which in former years decalcomania were attached to china and marble, to their supposed ornamentation.

The globe is now a study in black and white, and is ready for the etching proper.

The acid-room—for such is the name applied to the apartment where the etching process is carried out—is a truly villainous place. The atmosphere is so charged with hydrofluoric acid that it has a sharp smell and a most irritating effect upon the bodily economy generally. The instantaneous photograph of the bath had to be taken with more than customary expedition, lest the ninety-dollar lens in use should be fouled by the fumes. The man in charge of the process wears rubber gloves, and has his face partially protected from the fumes by a thick, bluish-white ointment. His appearance, in consequence, is far from prepossessing. The protection, however, is of a very superficial character. It leaves the eyes and the breathing apparatus entirely exposed. The operators soon show the ravages of the unwholesome atmosphere. Poor, pale ghosts of men, with red and blinking eyes, one wonders that, in a world so full of wholesome activities, they should be willing to sacrifice the best part of themselves in such an unnecessary cause. It is one of the saddest features of modern industrial life that things become so vastly more important than men, that both employers and employed—the responsibility is a joint one—come to look upon the ledger account as the first consideration and manhood the second. Dainty as are the products of this industrialism, I find myself taking less pleasure in them as I go more among the workers, and see what a price of dull routine and unwholesome labor is paid for the wares. If beautiful things are necessarily the product of unbeautiful lives, I am quite willing to forego the things. Under the present industrial *régime*, one feels almost an accessory to the degradation of human life if he purchase articles made on a large scale under the factory system. Morally, there is complicity, however unwilling we may be to admit it. It

is a question worth considering whether political freedom and industrial slavery represent an ideal with which any people may worthily remain content. An industrialism is conceivable, with hours so reasonable and conditions so wholesome that the lives of the workers shall be as beautiful as the wares they produce. Whether this will result from the present competitive system carried to its extreme, or from a substituted co-operative system, remains to be seen. In the atelier, the main process in operation is the transformation of moving, human energy into the stored-up

FIG. 9.—THE PORTLAND VASE.

energy represented by a highly wrought product. One may be pardoned, then, if his thought turns occasionally upon the source of the energy, the man. It is not an agreeable reflection to present to the reader that the majority of our brothers in large cities are living bitter, hateful lives, but I believe that it is a true one. It is perhaps well to entertain the thought for a moment, since our people, presumably sympathetic and compassionate, not only

do not deplore this sacrifice of the best elements in human life, but on the contrary hold up as an ideal for whose protection and extension the national policy should chiefly exert itself, that very industrialism under which this sacrifice takes place. Food, clothing, shelter, and the household goods and gods have value only as they minister to human life. But, by a curious inversion, these things are now held to be of greater importance than the life which they were originally intended to conserve. The savagery of modern times wears a different garb from that of the past, but it is none the less of the essence.

But to return to the acid-worker, for his besmeared face and irritated eyes are still before us. The three windows of the little room in which he works are kept open winter and summer, in the hope of diluting the poisonous fumes—a clumsy arrangement at the best. It would be quite possible to have the atmosphere, if not entirely wholesome, at least comparatively so, by placing the acid bath directly under a good flue or exhaust, so that the escaping fumes should be drawn off artificially. Every chemist's laboratory contains such an evaporating closet.

The hydrofluoric acid employed for etching is a chemical unfamiliar to the majority of people. Its corrosive character, and the fact that it has few common uses, preclude such an acquaintance. The source of the acid, however, the mineral fluor-spar, is quite abundant in nature. It is so beautiful a mineral, occurring in nearly all the colors of the rainbow and in well-defined cubes and octahedra, that it is given a prominent place in all mineralogical cabinets. It is, therefore, probably better known than the acid derived from it. The mineral itself is a fluoride of lime, and, when treated with oil of vitriol, gives off fumes of hydrofluoric acid. These are exceedingly soluble in water, forming the ordinary hydrofluoric acid of commerce. The bath used in etching the globes contains in addition a certain amount of oil of vitriol. Glass plunged into such a bath will have its surface eaten away, but will remain transparent. The wooden trough containing the bath is from three to four feet long, and less than a square foot in cross-section. Half a dozen globes are treated at a time. They are mounted on a steel axle, separated from each other by washers cut out of thick rubber. These serve the double purpose of protecting the glass from injury and of keeping the liquid out of the interior. When the axle is put in place in the trough, the globes are about half submerged in the bath. The axle is given a slow rotary motion, and, at the end of about fifteen minutes, the etching is completed. The globes are removed from the bath, and another axle carrying six fresh globes put in its place. The chemical action consists in the formation of gaseous fluoride of silicon, the bath affording the fluorine and the glass the silicon. It is

rendered more complete and more uniform by the rotary movement of the axle. The globes have now only to be washed, and nothing further remains but to sell them. The etching process is completed.

The solution of hydrofluoric acid leaves the etched portions of the glass transparent; but if some alkaline salt, such as ammonium or potassium sulphate, be present in the bath, the etched portions are rendered opaque. This reaction is utilized to obscure globes, in place of the grinding process already described. The globes have only to be dipped into such a bath for a moment or so, to be thoroughly obscured. As both sides of the glass are acted upon, the process of chemical obscuring is only used where the globe is not to be further decorated. In this same department the operation of "bisquing" is being carried on. If opalescent glass or colored translucent glass be dipped into such an alkaline bath for a brief time, it will take the dull finish characteristic of bisque. Thousands of the so-called fairy lamps, in red and pink and blue opalescent glass, are treated in this manner. Glass surfaces which are subsequently to be painted on are also bisqued in order to facilitate the process. A very brief immersion makes the surface sufficiently rough to write on with an ordinary lead-pencil without the least difficulty. The large white plaques exposed for sale in the art-stores are prepared in this manner. The bath is contained in large wooden tanks, and the articles are simply dipped in by hand.

The products of all these processes—of cutting, engraving, grinding, and etching—are all more or less beautiful. The highest excellence is attained, however, when the several processes are combined in the production of the once greatly admired cameo glass. The best of this is now manufactured in England, but it has also been made, though with less success, in America.

The prototype of this variety of glass is the celebrated Portland vase, with whose history and mishaps most people are familiar. It was found about the sixteenth century in a sarcophagus in the neighborhood of Rome, and for more than two centuries adorned the *salon* of the Barberini family. When their collection was sold, the vase was purchased by the Duchess of Portland, for eighteen hundred and seventy-two pounds, and was loaned to the British Museum. Even in such safe keeping it came very near complete destruction at the hands of a madman named Lloyd, who gave it a heavy blow with a stick. It has since been repaired with such ingenuity that one can scarcely distinguish the numerous fractures. The vase is supposed to date from the time of the Antonines, and is one of the finest examples of ancient glass-making extant. The body is of a deep-blue color and the raised figures are of opaque white. For many years archæologists be-

lieved that the vase was made of onyx, and described it as a most interesting cameo. It is now known to be made of glass composed of two layers.

The Portland vase was a hint to the glass-makers, and one that they made good use of. In the most elaborate examples of the modern product three colors are employed, and the effect, if the material has been judiciously managed, is exceedingly beautiful.

A vase is the best type of the cameo glass, since the function of the ware is almost wholly decorative. From beginning to end the process is one of great ingenuity. The basis of the vase is commonly of opalescent glass—that is, glass made opaque by the presence of some finely ground but insoluble oxide, or some such mineral as cryolite or fluor-spar. A lump of this glass is gathered on the end of the blowpipe and formed into a symmetrical shape by rolling on the marvering-table. It is then dipped at short intervals into two baths of molten glass of the colors desired. The composite lump is fashioned into shape by means of those various manipulations which the glass-blowers perform so adroitly. This gives a vase made up of three distinct layers of different colors. Its subsequent treatment is both chemical and mechanical. The design is painted on the glass by hand, or else transferred with special care from freshly printed paper, as in the case of the etched globes. The vase is then dipped into the bath of hydrofluoric acid and allowed to remain until both of the outer colors on the exposed portions are eaten off. It is now taken out, the ink washed off, and its subsequent treatment intrusted to the engraver. At this stage of the process only two out of the three colors are plainly visible, the intermediate one being seen simply as a colored line between the other two surfaces. By means of the engraving-wheel the outline of the design is made more clear cut, and enough of the outer layer removed to show the intermediate color as a delicate shading. An immense amount of work can thus be put upon a comparatively small article, and the cost meanwhile grows in proportion. Single pieces have been manufactured in England valued as high as two thousand dollars.

In spite of its great beauty and ingenuity, however, it is an undeniable fact that the cameo glass is losing rather than gaining in favor with the buying public. Some of the establishments which formerly produced it have ceased to do so. Several causes have been assigned for this lessened appreciation. Manufacturers say that the cost has been so far reduced that the rich will not buy it, and, in consequence, the middle classes no longer care for it. But such is not the general course of events in industrial matters, and the statement is to be taken with a grain of salt. The probable trouble is, that some of the cameo-ware has been

produced in distressing colors and in unfortunate combinations. Injudiciously managed, it is easily possible to produce meager and inartistic effects. The average buyer has, therefore, been disposed to reckon with himself that, dollar for dollar, he could get more beauty elsewhere, and has accordingly gone there. The intrinsic merit of the ware is such, however, that an early revival of interest in it may be expected.

The processes of the atelier are much more varied than those described. These special ones have been selected as being among the most characteristic, particularly of American establishments. Moreover, they are types, and have an independent interest as ingenious adaptations of means to ends.

Before closing the door upon the atelier, the factor of its *personnel* deserves a moment's attention. I refer now to the workers—not in their social or human capacity, but merely as merchandise-producers. Their labor is expended almost exclusively in the creation of supposed beauty. It is true that the work is lavished for the most part upon objects of utility; but still it would all fall under the head of ornamentation, since the utilitarian quality in the products has been conferred elsewhere than in the atelier. It is curious, then, in view of this end, to find the workers of the most inartistic cult. In other departments of glass-making, and notably in the production of picture-windows, the possibilities of the material have attracted artists of the highest rank, and the results have been quite worthy of their effort. No such artistic invasion has taken place in this department. Considering the lives and training of the workers, the surprise is that they have realized as much beauty as they have. There is nothing in the atmosphere they breathe to cultivate such a sentiment. It is related of a celebrated Japanese *cloissonné*-maker that, having acquired a considerable sum of money from the sale of some of his choice wares at one of the Paris expositions, he expended the entire amount in the creation of a beautiful garden around his work-rooms, believing that such an environment would inspire his people to produce even more beautiful wares. I presume that a spirit such as this is possible only where one works for excellence rather than for money.

According to Dr. S. T. Hickson, a naturalist-traveler, the people of the island of Sangir, near Celebes, suppose that, when a man is sick, his proper soul is driven out of him and replaced by a *sakit*, or soul of sickness; and they employ, to eject the evil spirit, a means of mild persuasion. God-cages or god-canoes, made of wood and ornamented with twigs and leaves, are hung up in the patient's dwelling, in which the *sakit*, if pleased with the substance and design of the structure, will take up its abode; after which, it is supposed, the sick man will immediately recover.

ATMOSPHERIC DUST.*

By Dr. WILLIAM MARCET, F.R.S.

THE infinitely small particles of matter we call *dust*, though possessed of a form and structure which escape the naked eye, play important parts in the phenomena of nature. A certain kind of dust has the power of decomposing organic bodies and bringing about in them definite changes known as putrefaction, while other kinds exert a baneful influence on health, and act as a source of infectious diseases. Again, from its lightness and extreme mobility, dust is a means of scattering solid matter over the earth. It may float in the atmosphere as mud does in water, and, blown by the wind, will perhaps travel thousands of miles before again alighting on the earth. Thus Ehrenberg, in 1828, detected in the air of Berlin the presence of organisms belonging to African regions; and he found in the air of Portugal fragments of infusoria from the prairies of America. The smoke of the burning of Chicago was, according to Mr. Clarence King, seen on the Pacific coast.

Dust is concerned in many interesting meteorological phenomena, such as fogs, as it is generally admitted that fogs are due to the deposit of moisture on atmospheric motes. Again, the scattering of light depends on the presence of dust, as is shown in one of Tyndall's interesting experiments. There is no atmosphere without dust, although it varies much in quantity, from the summit of the highest mountain, where the least is found, to the low plains, at the sea-side level, where it occurs most abundantly.

The origin of dust may be looked upon, without exaggeration, as universal. Trees shed their bark and leaves, which are powdered in dry weather and carried about by ever-varying currents of air; plants dry up and crumble into dust; the skin of man and animal is constantly shedding a fine material of a scaly form. The ground in dry weather, high roads under a midsummer's sun, emit clouds of dust consisting of very fine particles of earth. The fine river and desert sand, a species of dust, is silica ground down into a fine powder under the action of water. If the vegetable and mineral world crumbles into dust, on the other hand it is highly probable that dust was the original state of matter before the earth and heavenly bodies were formed; and here we enter the region of theory and probabilities. While it is best to avoid as much as possible stepping out of the track of known

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facts, there is a limit to physical observation, and in some cases we can do no more than glance into the possible or probable source of natural phenomena.

This has been done, as to the origin of the universe, by Prof. Norman Lockyer, in his article on the History of a Star. The author proposes there to clear in our imagination a limited part of space, and then set possible causes to work: that dark void will sooner or later be filled with some form of matter so fine that it is impossible to give it a chemical name; but the matter will eventually condense into a kind of dust mixed with hydrogen gas, and constitute what are called nebulæ. These nebulæ are found by spectrum analysis to be made up of known substances, which are magnesium, carbon, oxygen, iron, silicon, and sulphur. This dust comes down to us in a tangible form—dust shed from the sky on the earth, and large masses, magnificent specimens of meteorites, which have fallen from the heavens at different times, some of them weighing tons. There are swarms of dust traveling through space, and their motion may be gigantic. From photographs taken of the stars and nebulæ, we are entitled to conclude that the swarms of dust meet and interlace each other, becoming raised by friction and collision to a very high temperature, and giving rise to what looks like a star. The light would last so long as the swarms collide, but would go out should the collision fail; or, again, such a source of supply of heat may be withdrawn by the complete passage of one stream of dust-swarms through another. We shall, therefore, have various bodies in the heavens, suddenly or gradually increasing or decreasing in brightness, quite irregularly, unlike those other bodies where we get a periodical variation in consequence of the revolution of one of them round the other. Hence, as Mr. Lockyer expresses it, "it can not be too strongly insisted upon that the chief among the new ideas introduced by the recent work is that a great many stars are not stars like the sun, but simply collections of meteorites, the particles of which may be probably thirty, forty, or fifty miles apart." These swarms of dust undergo condensation by attraction or gravitation; they will become hotter and brighter as their volume decreases, and we shall pass from the nebulæ to what we call true stars. Mr. Lockyer imagines such condensed masses of meteoric dust being pelted or bombarded by meteoric material, producing heat and light, the effect continuing as long as the pelting is kept up. To this circumstance is due the formation of stars like suns. Our earth originally belonged to that class of heavenly bodies, but from a subsequent process of cooling assumed its present character.

The dust scattered everywhere in the atmosphere, which is lighted up in a sunbeam or a ray from the electric lamp, is of

an organic nature. It is seen to consist of countless motes, rising, falling, or gyrating, although it is impossible to follow any of them with the eye for longer than a fraction of a second. We conclude that their weight exceeds but very slightly that of the air; and, moreover, that the atmosphere is the seat of multitudes of minute currents, assuming all kinds of directions. One day last June, from the top of Eiffel's Tower in Paris, I amused myself by throwing an unfolded newspaper over the railing round the summit of the tower. At first it fell slowly, carried away by a light breeze; but presently it rose, and, describing a curve, began again to fall. As it was vanishing from sight, the paper seemed to me as if arrested now and then in its descent, perhaps undergoing again a slight upheaval. Here was, indeed, a gigantic mote floating in the atmosphere, and subject to the same physical laws, though on a larger scale, as those delicate filaments of dust we see dancing merrily in a sunbeam.

It is difficult to say how much of the dust present in the air may become a source of disease, and how much is innocuous. Many of the motes belong to the class of micro-organisms; and experiments show how easily these micro-organisms or sources of infectious diseases can reach the lungs, and do mischief if they should find a condition of the body on which they are able to thrive and be reproduced. Atmospheric motes, although it has been shown that they are really deposited in the respiratory organs, do not accumulate in the lungs and air-passages, but undergo decomposition and disappear in the circulation. Smoke, which is finely divided coal-dust, is clearly subjected to such a destructive process; otherwise the smoky atmosphere of many of our towns would soon prove fatal, and tobacco-smoke would leave a deposit interfering seriously after a very short time with the process of respiration. Dust, however in its physical aspect is very far from being always innocuous, and many trades are liable to suffer from it. The cutting of chaff, for horses' food, is one of the most pernicious occupations, as it generates clouds of dust of an essentially penetrating character. Persons engaged in needle manufacturing and steel-grinders suffer much from the dust of metallic particles. Stone-cutters, and workmen in plaster of Paris, coal-heavers, men engaged in the manufacture of cigars and rope, those employed in flour-mills and hat and carpet making, are liable to suffer from dust. A number of methods have been adopted, more or less successfully, to rid these trades of the danger due to this source. I observed many years ago that charcoal has the power of retaining dust in a remarkable degree, and having had respirators made of it, found them very effective in preventing dust reaching the lungs.

Micro-organisms—dust-like particles capable of cultivation or

reproduction in certain media and at certain temperatures—are scattered everywhere in the atmosphere. Interesting inquiries into their distribution in air and water have been made by Dr. Miquel at the Montsouris Observatory, Paris, and by Dr. Percy Frankland in England. Dr. Frankland has found that the number present is much reduced in winter. Experiments made in inclosed places, where there is little or no aërial motion, show the number of suspended organisms to be very moderate; but as soon as any disturbance in the air occurs, from draughts or people moving about, the number rapidly increases and may become very great. Being slightly heavier than air, they have an invariable tendency to fall, and on that account collect on the surface of water. Hence rivers, lakes, and ponds are constantly being thus contaminated.

Important points connected with dust of organic origin are its inflammability and its liability to explode when mixed with air. The property of explosiveness was forcibly illustrated in the destruction of six flour-mills by this cause in Minneapolis, Minn., in May, 1878. Coal-dust in coal-mines is a cause of accident from explosions which has been closely investigated in England, Germany, and other mining countries. The subject was thoroughly treated by Sir Frederick Abeel, in a paper on Accidents in Mines, read before the Institution of Civil Engineers in 1888.

Extremely fine particles of mineral dust may exist in the atmosphere, and do exist there more frequently than is generally thought, while they escape detection by our senses. The author, while making experiments on the Peak of Teneriffe, in 1878, found the knife-edges of his balance so clogged with this invisible dust that the balance refused to act. When wiped off, the dust collected again in a few minutes, and it was only by continually wiping it away that he was able to go on with his investigation. Prof. Piazzi Smyth, while on the Peak of Teneriffe, witnessed strata of dust rising to a height of nearly a mile, reaching out to the horizon in every direction, and so dense as to hide frequently the neighboring hills. Prof. S. P. Langley, looking down from the height of fifteen thousand feet on Mount Whitney, California, into a region that had appeared clear from the valley below, saw "a kind of level dust ocean, invisible from below, but whose depth was six or seven thousand feet, as the upper portion only of the opposite mountain-range rose clearly out of it."

Dust storms are classified by Dr. Henry Cook, according to their intensity, as atmospheric dust, dust columns, and dust storms. Dr. Cook has observed in India that there are some days on which, however hard and violently the wind may blow, no dust accompanies it, while on others every little puff of air or current of wind forms or carries with it clouds of dust. If the wind which

raises the dust is strong, nothing will be visible at the distance of a few yards, and the sun will be obscured. The dust penetrates everywhere, and can not be excluded from houses, boxes, and even watches, however carefully guarded. The individual particles of sand appear to be in such an electrical condition that they are ever ready to repel each other, and are consequently disturbed and carried up into the air. Dust columns are regarded by Dr. Cook as due to electrical causes. On calm, quiet days, when hardly a breath of air is stirring, and the sun pours down its heated rays with full force, little eddies arise in the atmosphere near the surface of the ground. These increase in force and diameter, catching up and whirling round bits of sticks, grass, dust, and lastly sand, until a column is formed of great height and considerable diameter, which usually, after remaining stationary for some time, sweeps away across country at great speed. Ultimately it loses gradually the velocity of its circular movement and disappears. In the valley of Mingochar, which is only a few miles in width, and surrounded by high hills, Dr. Cook, on a day when not a breath of air was stirring, counted upward of twenty of these columns. They seldom changed their places, and, when they did so, moved but slowly across the level tract. They never interfered with one another, and appeared to have independent existences. Mr. P. L. H. Baddeley, in his book on Whirlwinds and Dust Storms of India, tells of a gentleman at Lahore who fixed an electrometer apparatus, so adjusted as to report atmospheric electrical movements, and observed that it was strongly affected during dust storms.

Volcanic dust consists mainly of powdered vitrified substances, reduced by the action of intense heat. It is interesting in many respects. The ashes or scoria shot out in volcanic eruptions are mostly pounded pumice, but they also originate from stones and fragments which are pulverized by striking against each other. Volcanic dust has a whitish-gray color, and is sometimes nearly white. Thus it is that, in summer, the terminal cone of the Peak of Teneriffe appears from a distance as if covered with snow; but there is no snow on the mountain at that season of the year, and the white cap of the peak is due to pumice ejected centuries ago.

The friction caused by volcanic stones and rocks as they are crushed in their collision develops a mass of electricity which shows itself in brilliant displays of branch lightning darting from the edges of the dense ascending column. During the great eruption of Vesuvius in 1822 they were constantly visible, and added much to the grandeur of the spectacle. It not unfrequently happens that the dust emitted from Vesuvius falls into the streets of Naples; but this is nothing in comparison with the mass of finely powdered material which covered and buried the towns of Pompeii,

Herculaneum, and Stabiæ, in the year 79. The eruption of Krakatoa, in 1883, exceeded, in all probability, in its deadly effects, and as a wonderful phenomenon of nature, the outburst of Vesuvius in the year 79. It is shown, in the report of the Krakatoa Committee of the Royal Society, that the detonations caused by the explosive action were heard a hundred and fifty miles away. Captain Thompson, of the ship Medea, sailing at a point seventy-six miles northeast of Krakatoa, saw a black mass like smoke rising into the clouds to an altitude which was estimated as not less than seventeen miles. All the eye-witnesses agree as to the splendor of the electrical phenomena. The old crater of Krakatoa was eviscerated, and a cavity was formed more than a thousand feet deep. On the morning of the 27th of August three vessels at the eastern entrance of the Strait of Sunda encountered the fall of mingled dust and water, which soon darkened the air, and covered their decks and sails with a thick coating of mud. Some of the pieces of pumice falling on the Sir R. Sale were said to have been of the size of a pumpkin. All that day the three vessels were beating about in darkness, pumice-dust falling upon them in such quantities as to employ the crews for hours in shoveling it from the decks and in beating it from the sails and rigging. The speed and distance attained by the pumice ejected from the volcano may be conceived from the fact stated in Mr. Douglas Archibald's contribution to the report, that dust fell on September 8th more than thirty-seven hundred English miles from the seat of the eruption. The great mass of the pumice was of a dirty, grayish-white tint, and was very irregular in size.

The dust ejected from Krakatoa did not all fall back at the same time upon the sea and the earth. The lightest portion formed into a haze, which was as a rule propagated westward. Most observers agree in regarding this haze as the proximate cause of the twilight glows, colored suns, and large corona which were seen for a long time (more than two years) after the eruption. The haze was densest in the Indian Ocean and along the equatorial belt, and was often thick enough to hide the sun when within a few degrees of the horizon.

I hope I have succeeded in showing that infinitely small objects, no larger than particles of dust, act important parts in the physical phenomena of nature.

Mr. H. W. Seton-Karr tells, in one of his books of travels, of his ascent of one of the spurs of Mount St. Elias, following the track of a brown bear with always an uneasy expectation of meeting the animal itself, to the height of seven thousand two hundred feet. Here the wonderful spectacle was presented of no less than seventeen thousand square miles of glaciers stretching over the face of the country. Excepting Greenland, according to this traveler, these glaciers are the most extensive in the world outside of the arctic and antarctic regions.

ON JUSTICE.

By HERBERT SPENCER.

[*Concluded.*]

IV. The Sentiment of Justice.—Acceptance of the doctrine of organic evolution determines certain ethical conceptions. The doctrine implies that the numerous organs in each of the innumerable species of animals, have been either directly or indirectly molded into fitness for the requirements of life by constant converse with those requirements. Simultaneously, through nervous modifications, there have been developments of the sensations, instincts, emotions, and intellectual aptitudes, needed for the appropriate uses of these organs; as we see in caged rodents that exercise their incisors by purposeless gnawing, in gregarious creatures which are miserable if they can not join their fellows, in beavers which, kept in confinement, show their passion for dam-building by heaping up whatever sticks and stones they can find.

Has this process of mental adaptation ended with primitive man? Are human beings incapable of having their feelings and ideas progressively adjusted to the modes of life imposed on them by the social state into which they have grown? Shall we suppose that the nature which fitted them to the exigencies of savage life has remained unchanged, and will remain unchanged, by the exigencies of civilized life? Or shall we suppose that this aboriginal nature, by repression of some traits and fostering of others, is made to approach more and more to a nature which finds developed society its appropriate environment, and the required activities its normal ones? There are many believers in the doctrine of evolution who seem to have no faith in the continued adaptability of mankind. While glancing but carelessly at the evidence furnished by comparisons of different human races with one another, and of the same races in different ages, they ignore entirely the induction from the phenomena of life at large. But if there is an abuse of the deductive method of reasoning there is also an abuse of the inductive method. One who refused to believe that a new moon would in a fortnight become full, and, disregarding observations accumulated throughout the past, insisted on watching the successive phases for three weeks before he was convinced, would be considered inductive in an irrational degree. But there might not unfairly be classed with him those who, slighting the inductive proof of unlimited adjustability, bodily and mental, which the animal kingdom at large presents, will not admit the adjustability of human nature to social life until the adjustment has taken place: nay, even ignore the evidence that it is taking place.

Here we shall assume it to be an inevitable inference from the doctrine of organic evolution, that the highest type of living being, no less than all lower types, must go on molding itself to those requirements which circumstances impose. And we shall, by implication, assume that moral changes are among the changes thus wrought out.

The fact that when surfeit of a favorite food has caused sickness, there is apt to follow an aversion to that food, shows how, in the region of the sensations, experiences establish associations which influence conduct. And the fact that the house in which a wife or child died, or in which a long illness was suffered, becomes so associated with painful states of mind as to be shunned, sufficiently illustrates, in the emotional region, the mode in which actions may be determined by mental connections formed in the course of life. When the circumstances of a species make certain relations between conduct and consequence habitual, the appropriately-linked feelings may come to characterize the species. Either inheritances of modifications produced by habit, or more numerous survivals of individuals having nervous structures which have varied in fit ways, gradually form guiding tendencies, prompting appropriate behavior and deterring from inappropriate. The contrast between fearless birds found on islands never before visited by man, and the birds around us, which show fear of man immediately they are out of the nest, exemplifies such adaptations.

By virtue of this process there have been produced to some extent among lower creatures, and there are being further produced in man, the sentiments appropriate to social life. Aggressive actions, while they are habitually injurious to the group in which they occur, are not unfrequently injurious to the individuals committing them; since, though certain pleasures may be gained by them, they often entail pains greater than the pleasures. Conversely, conduct restrained within the required limits, calling out no antagonistic passions, favors harmonious co-operation, profits the group, and, by implication, profits the average of its individuals. Consequently, there results, other things equal, a tendency for groups formed of members having this adaptation of nature, to survive and spread.

Among the social sentiments thus evolved, one of chief importance is the sentiment of justice. Let us now consider more closely its nature.

Stop an animal's nostrils, and it makes frantic efforts to free its head. Tie its limbs together, and its struggles to get them at liberty are violent. Chain it by the neck or leg, and it is some time before it ceases its attempts to escape. Put it in a cage, and

it long continues restless. Generalizing these instances we see that in proportion as the restraints on actions by which life is maintained are extreme, the resistances to them are great. Conversely, the eagerness with which a bird seizes the opportunity for taking flight, and the joy of a dog when liberated, show how strong is the love of unfettered movement.

Displaying like feelings in like ways, man displays them in other and wider ways. He is irritated by invisible restraints as well as by visible ones; and as his evolution becomes higher, he is affected by circumstances and actions which in more remote ways aid or hinder the pursuit of ends. A parallel will elucidate this truth. Primitively the sentiment of property is gratified only by possession of food and shelter, and, presently, of clothing; but afterward it is gratified by possession of the weapons and tools which aid in obtaining these, then by possession of the raw materials serving for making weapons and tools and for other purposes, then by possession of the coin which purchases them as well as things at large, then by possession of promises to pay exchangeable for the coin, then by a lien on a banker, registered in a pass-book. That is, there comes to be pleasure in an ownership more and more abstract and remote from material satisfactions. Similarly with the sentiment of justice. Beginning with the joy felt in ability to use the bodily powers and gain the resulting benefits, accompanied by irritation at direct interferences, this gradually responds to wider relations: being excited now by the incidents of personal bondage, now by those of political bondage, now by those of class privilege, and now by small political changes. Eventually, this sentiment, sometimes so little developed in the negro that he jeers at a liberated companion because he has no master to take care of him, becomes so much developed in the Englishman that the slightest infraction of some mode of formal procedure at a public meeting or in Parliament which can not intrinsically concern him, is vehemently opposed because in some distant and indirect way it may help to give possible powers to unnamed authorities who may perhaps impose unforeseen burdens or restrictions.

Clearly, then, the egoistic sentiment of justice is a subjective attribute which answers to that objective requirement constituting justice—the requirement that each adult shall receive the good and evil effects of his own nature. For unless the faculties of all kinds have free play, these results can not be gained or suffered, and unless there exists a sentiment which prompts maintenance of the sphere for this free play, it will be trenched upon and the free play impeded.

While we may thus understand how the egoistic sentiment of justice is developed, it is much less easy to understand how there

is developed the altruistic sentiment of justice. On the one hand, the implication is that the altruistic sentiment of justice can come into existence only in the course of adaptation to social life. On the other hand the implication is that social life is made possible only by maintenance of those equitable relations which imply the altruistic sentiment of justice. How can these reciprocal requirements be fulfilled?

The answer is that the altruistic sentiment of justice can come into existence only by the aid of a sentiment which temporarily supplies its place and restrains the actions prompted by pure egoism—a pro-altruistic sentiment of justice as we may call it. This has several components which we must successively glance at.

The first deterrent from aggression is one which we see among animals at large—the fear of retaliation. Among creatures of the same species the food obtained by one or place of vantage taken possession of by it, is in some measure insured to it by the dread which most others feel of the vengeance which may follow any attempt to take it away; and among men, especially during primitive stages of social life, it is chiefly such dread which secures for each man free scope for his activities, and exclusive use of whatever they bring him.

A further restraint is the fear of reprobation shown by unconcerned members of the group. Though in the expulsion of a "rogue" elephant from the herd, or the slaying of a sinning member of the flock by rooks or storks, we see that even among animals individuals suffer from an adverse public opinion; yet it is scarcely probable that among animals expectation of general dislike prevents encroachment. But among mankind, "looking before and after" to a greater extent, the thought of social disgrace is usually an additional check on ill-behavior of man to man.

To these feelings, which come into play before there is any social organization, have to be added those which arise after political authority establishes itself. When a successful leader in war acquires permanent headship, and comes to have at heart the maintenance of his power, there arises in him a desire to prevent the trespasses of his people one against another; since the resulting dissensions weaken his tribe. The rights of personal vengeance and, as in feudal times, of private war, are restricted; and, simultaneously, there grow up interdicts on the acts which cause them. Dread of the penalties which follow breaches of these, is an added restraint.

Ancestor-worship in general, developing as the society develops into special propitiation of the dead chief's ghost, and presently the dead king's ghost, gives to the injunctions he uttered during life increased sanctity; and when, with establishment of

the cult, he becomes a god, his injunctions become divine commands with dreaded punishments for breaches of them.

These four kinds of fear co-operate. The dread of retaliation, the dread of social dislike, the dread of legal punishment, and the dread of divine vengeance, united in various proportions, form a body of feeling which checks the primitive tendency to pursue the objects of desire without regard to the interests of fellow-men. Containing none of the altruistic sentiment of justice, properly so called, this pro-altruistic sentiment of justice serves temporarily to cause respect for one another's claims, and so to make social co-operation possible.

Creatures which become gregarious tend to become sympathetic in degrees proportionate to their intelligences. Not, indeed, that the resulting sympathetic tendency is exclusively, or even mainly, of that kind which the words ordinarily imply; for in some there is little beyond sympathy in fear, and in others little beyond sympathy in ferocity. All that is meant is that in gregarious creatures a feeling displayed by one is apt to arouse kindred feelings in others, and is apt to do this in proportion as others are intelligent enough to appreciate the signs of the feeling. In two chapters of the Principles of Psychology—Sociality and Sympathy and Altruistic Sentiments—I have endeavored to show how sympathy in general arises, and how there is eventually produced altruistic sympathy.

The implication is, then, that the associated state having been maintained among men by the aid of the pro-altruistic sentiment of justice, there have been maintained the conditions under which the altruistic sentiment of justice itself can develop. In a permanent group there occur, generation after generation, incidents simultaneously drawing from its members manifestations of like emotions—rejoicings over victories and escapes, over prey jointly captured, over supplies of wild food discovered; as well as laments over defeats, scarcities, inclemencies, etc. And to these greater pleasures and pains felt in common by all, and so expressing themselves that each sees in others the signs of feelings like those which he has and is displaying, must be added the smaller pleasures and pains daily resulting from meals taken together, amusements, games, and from the not infrequent adverse occurrences which affect several persons at once. Thus there is fostered that sympathy which makes the altruistic sentiment of justice possible.

But the altruistic sentiment of justice is slow in assuming a high form, partly because its primary component does not become highly developed until a late phase of progress, partly because it is relatively complex, and partly because it implies a stretch of

imagination not possible for low intelligences. Let us glance at each of these reasons.

Every altruistic feeling presupposes experience of the corresponding egoistic feeling. As, until pain has been felt there can not be sympathy with pain, and as one who has no ear for music can not enter into the pleasure which music gives to others; so, the altruistic sentiment of justice can arise only after the egoistic sentiment of justice has arisen. Hence where this has not been developed in any considerable degree, or has been repressed by a social life of an adverse kind, the altruistic sentiment of justice remains rudimentary.

The complexity of the sentiment becomes manifest on observing that it is not concerned only with concrete pleasures and pains, but is concerned mainly with certain of the circumstances under which these are obtainable or preventable. As the egoistic sentiment of justice is gratified by maintenance of those conditions which render achievement of satisfactions unimpeded, and irritated by the breaking of those conditions, it results that the altruistic sentiment of justice requires for its excitement not only the ideas of such satisfactions, but also the ideas of those conditions which are in the one case maintained and in the other case broken.

Evidently, therefore, to be capable of this sentiment in a developed form, the faculty of mental representation must be relatively great. Where the feelings with which there is to be sympathy are simple pleasures and pains, the higher gregarious animals occasionally display it: pity and generosity are from time to time felt by them as well as by human beings. But to conceive simultaneously not only the feelings produced in another, but the plexus of acts and relations involved in the production of such feelings, presupposes the putting together in thought of more elements than an inferior creature can grasp at the same time. And when we come to those most abstract forms of the sentiment of justice which are concerned with public arrangements, we see that only the higher varieties of men are capable of so conceiving the ways in which good or bad institutions and laws will eventually affect their spheres of action, as to be prompted to support or oppose them; and that only among these, therefore, is there excited under such conditions that sympathetic sentiment of justice which makes them defend the political interests of fellow-citizens.

There is, of course, a close connection between the sentiment of justice and the social type. Predominant militancy, by the coercive form of organization it implies, alike in the fighting body and in the society which supports it, affords no scope for the egoistic sentiment of justice; but, contrariwise, perpetually tramples on it, and at the same time the sympathies which origi-

nate the altruistic sentiment of justice are perpetually seared by militant activities. Contrariwise, in proportion as the *régime* of *status* is replaced by the *régime* of contract, or, in other words, as fast as voluntary co-operation, which characterizes the industrial type of society, becomes more general than involuntary co-operation, which characterizes the militant type of society, individual activities become less restrained, and the sentiment which rejoices in the scope for them is encouraged; while, simultaneously, the occasions for repressing the sympathies become less frequent. Hence during warlike phases of social life the sentiment of justice retrogrades, while it advances during peaceful phases, and can reach its full development only in a permanently peaceful state.*

V. THE IDEA OF JUSTICE.—While describing the sentiment of justice, the way has been prepared for describing the idea of justice. Though the two are intimately connected they may be clearly distinguished.

One who had dropped his pocket-book, and, turning round, finds that another who has picked it up will not surrender it, is indignant. If the goods sent home by a shopkeeper are not those he purchased, he protests against the fraud. Should his seat at a theatre be usurped during a momentary absence he feels himself ill-used. Morning noises from a neighbor's poultry he complains of as grievances. And meanwhile he sympathizes with the anger of a friend who has been led by false statements to join a disastrous enterprise, or whose action at law has been rendered futile by a flaw in the procedure. But though in these cases his sense of justice is offended, he may fail to distinguish the essential trait which in each case causes the offense. He may have the sentiment of justice in full measure while his idea of justice remains vague.

This relation between sentiment and idea is a matter of course. The ways in which men trespass on one another become more numerous in their kinds, and more involved, as society grows more complex; and they must be experienced in their many forms, generation after generation, before analysis can make clear the essential distinction between legitimate acts and illegitimate acts.

A special reason for this should be recognized. Ideas as well as sentiments must on the average be adjusted to the social state. Hence, as war has been frequent or habitual in nearly all societies, such ideas of justice as have existed have been perpetually con-

* Permanent peace does in a few places exist, and where it exists the sentiment of justice is exceptionally strong and sensitive. I am glad to have again the occasion for pointing out that among tribes called uncivilized, there are some, distinguished by the entire absence of warlike activities, who in their characters put to shame the peoples called civilized. In Political Institutions, §§ 437 and 574, I have given eight examples of this connection of facts taken from races of different types.

fused by the conflicting requirements of internal amity and external enmity.

Already it has been made clear that the idea of justice, or at least the idea of human justice, contains two elements. On the one hand there is that positive element implied by recognition of each man's claims to unimpeded activities and the benefits they bring. On the other hand there is that negative element implied by the consciousness of limits which the presence of other men having like claims necessitates. Two opposite traits in these two components especially arrest the attention.

Inequality is the primordial idea suggested. For if the principle is that each shall receive the benefits and evils due to his own nature and consequent conduct, then since men differ in their powers there must be differences in the results of their actions. Unequal amounts of benefit are implied.

Mutual limitations to men's actions suggest a contrary idea. When it is seen that if each pursues his ends regardless of his neighbor's claims, quarrels must be caused and social co-operation hindered, there arises the consciousness that bounds must be set to the doings of each; and the thought of spheres of action bounded by one another, involves the conception of equality.

Unbalanced appreciations of these two factors in human justice lead to divergent moral and social theories, which we must now glance at.

In some of the rudest groups of men the appreciations are no higher than those which we see among inferior gregarious animals. Here the stronger takes what he pleases from the weaker without exciting general reprobation; while, elsewhere, there is practiced and tacitly approved something like communism. But where habitual war has developed political organization, the idea of inequality becomes predominant. If not among the conquered, who are made slaves, yet among the conquerors, who naturally think of that which conduces to their interest as that which *ought* to be, there is fostered this element in the conception of justice which asserts that superiority shall have the benefits of superiority.

Though the Platonic dialogues may not be taken as measures of Greek belief, yet we may reasonably assume that the things they take for granted were currently accepted. Socrates inquires —"Do you admit that it is just for subjects to obey their rulers?" "I do," replies Thrasymachus.* Though otherwise in antagonism,

* The Republic, Book I, translated by Jowett, p. 159 (edit. of 1871). Instead of "Do you admit," the rendering given by Messrs. Llewelyn Davies and Vaughan is "You doubtless also maintain."

the two agree in this conception of what is just. At a later stage of the inquiry, Glaucon, describing a current opinion, says:

"This, as they affirm, is the origin and nature of justice:—there is a mean or compromise between the best of all, which is to do and not to suffer injustice, and the worst of all, which is to suffer without the power of retaliation; and justice being the mean between the two, is tolerated not as good, but as the lesser evil." And immediately afterward it is said that men "are only diverted into the path of justice by the force of law."*

In this significant passage several things are to be noted. There is first a recognition of the fact, above indicated, that at an early stage the practice of justice is initiated by the dread of retaliation, and the conviction, suggested by experience, that it is on the whole the best to avoid aggression and to respect the limit which compromise implies; there is no recognition of intrinsic flagitiousness in aggression, but only of its impolicy. Further, the limit to each man's actions, described as "a mean of compromise," and respect for which is called "the path of justice," is said to be established only "by the force of law." Law is not considered as an expression of justice otherwise cognizable, but as itself the source of justice; and hence results the meaning of the preceding proposition, that it is just to obey the law. Thirdly, there is an implication that were it not for retaliation and legal penalties, the stronger might with propriety take advantage of the weaker. There is a half-expressed belief that superiority ought to have the advantages of superiority; inequality occupies a prominent place, while equality makes no definite appearance.

The conception here indicated that justice consists in legality, is, toward the close of Book IV, developed into the conception that justice consists "in each of the three classes doing the work of its own class": carpenter, shoemaker, or what not, "doing each his own business, and not another's"; and all obeying the class whose business it is to rule.† Thus the idea of justice is made to include the idea of inequality. Though there is some recog-

* Book II, p. 229.

† On another page there is furnished a typical example of Socratic reasoning. It is held to be a just "principle that individuals are neither to take what is another's, nor to be deprived of what is their own." From this it is inferred that justice consists in "having and *doing* what is a man's own"; and then comes the further inference that it is unjust for one man to assume another's occupation, and "force his way" out of one class into another. Here, then, because a man's own property and his own occupation are both called his own, the same conclusion is drawn concerning both. Two fallacies are involved—the one that a man can "own" a trade in the same way that he owns a coat, and the other that because he may not be *deprived* of the coat he must be *restricted* to the trade. The Platonic dialogues are everywhere vitiated by fallacies of this kind, caused by confounding words with things—unity of name with unity of nature.

nition of equality of positions and claims among members of the same class, yet the regulations respecting community of wives, etc., in the guardian-class, have for their avowed purpose to establish, even within that class, unequal privileges for the benefit of the superior.

But now observe that while in the Greek conception of justice there predominates the idea of inequality, while the idea of equality is inconspicous, the inequality refers, not to the natural achievement of greater rewards by greater merits, but to the artificial apportionment of greater rewards to greater merits. It is an inequality mainly established by authority. The gradations in the civil organization are of the same nature as those in the military organization. Regimentation pervades both, and the idea of justice is everywhere conformed to the traits of the social structure.

And this is the idea of justice proper to the militant type at large, as we are again shown throughout Europe in subsequent ages. It will suffice to point out that along with the different law-established positions and privileges of different ranks, there went gradations in the amounts paid in composition for crimes according to the rank of the injured. And how completely the idea of justice was determined by the idea of rightly-existing inequality, is shown by the condemnation of serfs who escaped into the towns and were said to have "unjustly" withdrawn themselves from the control of their lords.

Thus, as might be expected, we find that while the struggle for existence between societies is going on actively, recognition of the primary factor in justice which is common to life at large, human and sub-human, is very imperfectly qualified by recognition of the secondary factor. That which we may distinguish as the brute element in the conception is but little mitigated by the human element.

All movements are rhythmical, and among others social movements, with their accompanying doctrines. After that conception of justice in which the idea of inequality unduly predominates, comes a conception in which the idea of equality unduly predominates.

A recent example of such reactions is furnished by the ethical theory of Bentham. As is shown by the following extract from Mr. Mill's Utilitarianism (p. 91), the idea of inequality here entirely disappears:

> The Greatest-Happiness Principle is a mere form of words without rational signification, unless one person's happiness, supposed equal in degree (with the proper allowance made for kind), is counted for exactly as much as another's. Those conditions being supplied, Bentham's dictum, "everybody to count for one,

nobody for more than one," might be written under the principle of utility as an explanatory commentary.

Now though Bentham ridicules the taking of justice as our guide, saying that while happiness is an end intelligible to all, justice is a relatively unintelligible end, yet he tacitly asserts that his principle—"everybody to count for one, nobody for more than one," is just; since, otherwise, he would be obliged to admit that it is unjust, and we may not suppose he would do so. Hence the implication of his doctrine is that justice means an equal apportionment of the benefits, material and immaterial, which men's activities bring. There is no recognition of inequalities in men's shares of happiness, consequent on inequalities of their faculties or characters.

This is the theory which Communism would reduce to practice. From one who knows him, I learn that Prince Krapotkin blames the English socialists because they do not propose to act out the rule popularly worded as "share and share alike." In a recent periodical, M. de Laveleye summed up the communistic principle as being "that the individual works for the profit of the State, to which he hands over the produce of his labor for equal division among all." In the communistic Utopia described in Mr. Bellamy's Looking Backward, it is held that each "shall make the same effort," and that if by the same efforts, bodily or mental, one produces twice as much as another, he is not to be advantaged by the difference. At the same time the intellectually or physically feeble are to be quite as well off as others: the assertion being that the existing *régime* is one of "robbing the incapable class of their plain right in leaving them unprovided for."

The principle of inequality is thus denied absolutely. It is assumed to be unjust that superiority of nature shall bring superiority of results, or, at any rate, superiority of material results; and as no distinction appears to be made in respect either of physical qualities or intellectual qualities or moral qualities, the implication is not only that strong and weak shall fare alike, but that foolish and wise, worthy and unworthy, mean and noble, shall do the same. For if, according to this conception of justice, defects of nature, physical or intellectual, ought not to count, neither ought moral defects, since they are one and all primarily inherited.

And here, too, we have a deliberate abolition of that cardinal distinction between the ethics of the family and the ethics of the State emphasized at the outset: an abolition which must eventuate in decay and disappearance of the species or variety in which it takes place.

After contemplation of these divergent conceptions of justice, in which the ideas of inequality and equality almost or quite ex-

clude one another, we are prepared for framing a true conception of justice.

In other fields of thought it has fallen to my lot to show that the right view is obtained by co-ordinating the antagonist wrong views. Thus, the association-theory of intellect is harmonized with the transcendental theory on perceiving that when, to the effects of individual experiences are added the inherited effects of experiences received by all ancestors, the two views become one. So, too, when the molding of feelings into harmony with requirements, generation after generation, is recognized as causing an adapted moral nature, there results a reconciliation of the expediency-theory of morals with the intuitional theory. And here we see that the like occurs with this more special component of ethics now before us.

For if each of these opposite conceptions of justice is accepted as true in part, and then supplemented by the other, there results that conception of justice which arises on contemplating the laws of life as carried on in the social state. The equality concerns the mutually-limited spheres of action which must be maintained if associated men are to co-operate harmoniously. The inequality concerns the results which each may achieve by carrying on his actions within the implied limits. No incongruity exists when the ideas of equality and inequality are applied the one to the bounds and the other to the benefits. Contrariwise, the two may be, and must be, simultaneously asserted.

Other injunctions which ethics has to utter do not here concern us. There are the self-imposed requirements and limitations of private conduct, forming that large division of ethics treated of in Part III; and there are the demands and restraints included under Negative and Positive Beneficence, to be hereafter treated of, which are at once self-imposed and in a measure imposed by public opinion. But here we have to do only with those claims and those limits which have to be maintained as conditions to harmonious co-operation, and which alone are to be enforced by the society in its corporate capacity.

Any considerable acceptance of so definite an idea of justice is not to be expected. It is an idea appropriate to an ultimate state, and can be but partially recognized during transitional states; for the prevailing ideas must, on the average, be congruous with existing institutions and activities.

The two essentially-different types of social organization, militant and industrial, based respectively on *status* and on contract, have, as we have above seen, feelings and beliefs severally adjusted to them; and the mixed feelings and beliefs appropriate to intermediate types, have continually to change according to the

ratio between the one and the other. As I have elsewhere shown,* during the thirty—or rather forty—years' peace, and consequent weakening of the militant organization, the idea of justice became clearer: coercive regulations were relaxed and each man left more free to make the best of himself. But, since then, the redevelopment of militancy has caused reversal of these changes; and, along with nominal increases of freedom, actual diminutions of freedom have resulted from multiplied regulations and exactions. The spirit of regimentation proper to the militant type has been spreading throughout the administration of civil life. An army of workers with appointed tasks and apportioned shares of products, which socialism, knowingly or unknowingly, aims at, shows in civil life the same characters as an army of soldiers with prescribed duties and fixed rations shows in military life; and every further act of Parliament which takes from the individual money for public purposes and gives him public benefits, tends more and more to assimilate the two. Germany best shows this kinship. There, where militancy is most pronounced, and where the regulation of citizens is most elaborate, socialism is most highly developed; and from the head of the German military system has now come the proposal of regimental regulations for the working classes throughout Europe.

Sympathy which, a generation ago, was taking the shape of justice, is relapsing into the shape of generosity; and the generosity is exercised by inflicting injustice. Daily legislation betrays little anxiety that each shall have that which belongs to him, but great anxiety that he shall have that which belongs to somebody else For while no energy is expended in so reforming our judicial administration that every one may obtain and enjoy all he has earned, great energy is shown in providing for him and others benefits which they have not earned. Along with that miserable *laissez-faire* which calmly looks on while men ruin themselves in trying to enforce by law their equitable claims, there goes activity in supplying them, at other men's cost, with *gratis* novel-reading!

Evidently, then, amid this chaos of opinions the true idea of justice can be but very partially recognized. The workman who, in pursuance of it, insists on his right of making his own contract with an employer, will continue to be called "a black-leg"; and the writer who opposes the practice of forcibly taking A's property for B's benefit will be classed as an "*a priori* bigot."—*Nineteenth Century.*

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* Principles of Sociology, §§ 266, 267; Political Institutions, §§ 573, 574 and 559.

EVIDENCES OF GLACIAL ACTION IN SOUTH-EASTERN CONNECTICUT.

By Hon. DAVID A. WELLS.

REMARKABLE evidences of glacial action in southeastern Connecticut seem thus far to have almost entirely escaped the attention of geologists. In fact, the most superficial survey of the section of country bordering on Long Island and Fisher's Island Sounds, and extending from Connecticut River on the west to Watch Hill, and perhaps to a point farther east, in Rhode Island, can hardly fail to produce a conviction that it was in this region that one, at least, of the great New England glaciers debouched into the waters of the Atlantic; unloading or drop-

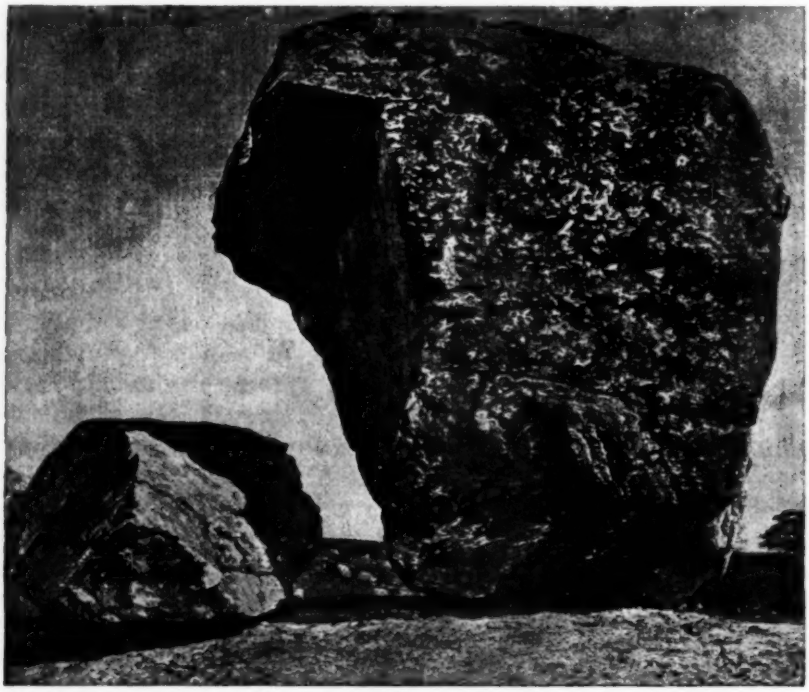

Fig. 1.

ping, as its progress was arrested by the ocean, or as it subsequently gradually wasted and receded by change of climate, a vast multitude of bowlders, of which a very large proportion are of uncommon magnitude. There would also seem some reasons for believing that the central or medium line of this glacier is now indicated by the course of the so-called Thames River—which is more properly an arm of the sea rather than a river—

and represents a deep but comparatively narrow cut in the underlying hard granitic rocks; and which, certainly near its mouth, to a depth of fifty feet or more beneath the present river-bottom, as was shown by the recent borings in connection with the construction of the Shore Line Railroad Bridge at New London, is now filled up with mud or coarser detritus. East of the mouth of the Thames River the shores of the mainland, and the surface of the numerous little adjoining islands, are strewed with bowlders—many of large size, and often resting on a highly smoothed basis of bed-rock without the intervention of any surface soil whatever; as is illustrated by Fig. 1, which represents (from a photograph) a bowlder (and the changes in the way of destruction which such masses of rock are undergoing), between Groton and Noank, on the line of the New London and Providence Railroad, and which is a very conspicuous object as seen from the cars, on the left hand side of the track going east.*

The number and size of the bowlders that are strewed over the bottom of Fisher's Island Sound are also a matter of interest and

FIG. 2.

wonderment to even those least acquainted with the subject, who sail over and fish in its shallow waters; while Fisher's Island itself is little other than a mass of bowlders covered in great part by sand, and probably marks the terminal line where a heavy ocean surf arrested the further progress of the glacier by

* All the illustrations accompanying this paper are reproduced from photographic pictures.

breaking in upon its structure, floating off its ice-fragments in the form of bergs or floes, and, by releasing at the same time its heavier rock and gravel constituents, built up a breakwater which, as an island, now forms what is known as "Fisher's Island Sound." Fig. 2 represents a not unfrequent example of the char-

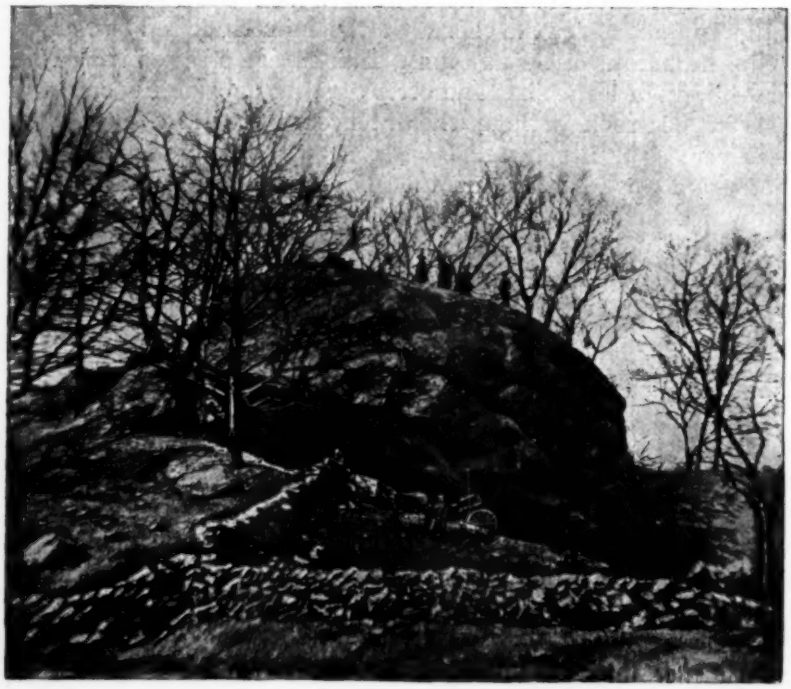

FIG. 3.

acter of the materials which enter into the construction of this natural breakwater, as seen from the western side of this island.

But it is in the region to the east and west of the line of the Thames River, and which it has been suggested may have been the axis of the ancient glacier, and not very far removed from this line, that bowlders of extraordinary size occur most numerously; and among them is a rock which until very recently has been regarded as one of the largest, if not the very largest, bowlder that has thus far been recognized in this or any other country. This rock—of coarse crystalline granite—is situated in the town of Montville, New London County, about six miles south of Norwich, and about a mile west of the Montville Station on the New London and Northern Railroad; and, under the Indian name of "Sheegan," has almost from the first settlement of the country been recognized as a great natural curiosity. Its position is on the edge of a gentle mound or knoll, on the northeast slope of a little valley; and its dimensions, according to recent

measurements by Prof. Crosby, of the Boston Society of Natural History, are as follows: northwest side, forty-six feet; northeast, fifty-eight; southeast, forty-five; southwest, seventy. Maximum height, reckoning from the lower or down-hill side, to the highest point on the upper side, approximately, sixty feet; approximate cubic contents, seventy thousand cubic feet; approximate weight, about six thousand tons. Other and former reported measurements of this rock indicate much larger dimensions than those reported by Prof. Crosby; and, although the determinations of an expert observer like the latter are entitled to the greatest confidence, it is nevertheless true that the form of the rock is so irregular as to render an exact estimate of its size, cubical contents, and weight a matter of no little difficulty. Figs. 3 and 4 give an idea of the position, size, and appearance of the "Sheegan" Rock, as seen from the valley beneath it, looking west. The introduction into the picture of the horse and wagon beneath the rock affords in some degree a standard for estimating its height. The cavity or recess beneath the rock, which is said to have been occupied, at the time of the first settlement of the country, by a

FIG. 4.

Mohegan Indian (from whom the rock undoubtedly derived its name) as a dwelling-place, is sufficiently capacious to admit of being used as a place of shelter for the sleds and other farm implements of the farmer proprietor. A rude ladder on the southern side of the rock affords facilities for reaching its top and obtaining a somewhat extensive view of the surrounding country.

It will probably have been noticed in the above description

that the expression, "has been regarded" as a bowlder, has been employed. The reason of this is, that a recent examination of this rock (in March, 1890) has led Prof. Crosby to the somewhat startling conclusion that it is not a bowlder, but "simply an angular and prominent remnant of a large granite vein, still undisturbed in its original position upon beds of gneiss; and that its chief geological interest is found in the fact that, notwithstanding its

FIG. 5.

exposed position, it has survived the disintegrating influence of the elements and successfully resisted the pressure of the great ice-sheet." Prof. Crosby also states that, "through the undercutting action of the frost, forming quite an extensive rock-shelter" (i. e., the cavity or recess on the lower or valley side), "is afforded an opportunity to observe the actual contact of the massive granite and the finely laminated micaceous gneiss" upon which the granite rests.

For one of very limited experience to dispute the conclusions of such a trained observer as Prof. Crosby would be presumptuous; and yet it would not seem unreasonable to ask that they should not be considered as entirely determinative without a further careful examination of the problem on the part of experts. The question as to whether the contact of the granite of the assumed bowlder and the underlying gneiss is one of situation or of composition is not an easy one for decision, without a very clear opportunity for examination. The fact that such a

huge mass of granite should have resisted the pressure of a great ice-sheet, and remained so prominently in place as part of a vein, when such pressure and an accompanying movement and grinding were sufficient to not only round off and obliterate everything like angularity from the granite surface, but also remove or reduce down to a much lower level and over a large proximate area the whole vast mass of rock on which the granite protuberance, if it be a portion of a vein, must have been as it were originally imbedded, is, as Prof. Crosby admits, a result not a little singular. There is certainly nothing analogous to such a phenomenon in the vicinity, and it may well be questioned whether there is anything similar anywhere.

Furthermore, as throwing some light on this subject, there are, as before stated, in comparative proximity to the "Sheegan" Rock, a large number of undoubted bowlders of the same granite, which, though not comparable as regards size, may yet be regarded as extraordinary, and as clearly involving the exercise of an enormous disrupting and transporting power within a rather limited area. One of these bowlders in the same township of Montville, which is also an object of public curiosity, and known as the "Goal" Rock, is, according to measurements made for the writer, twenty-one feet high, twenty-five long, and twenty-five thick. Another, in the vicinity of Gardner's Lake, from which nearly one fourth of the original mass has been detached in fragments, is reported as eighteen feet six inches high, thirty-five feet long, and twenty feet thick. A third, on the east side of the Thames River, in the town of Preston, is fourteen feet high, twenty feet long, and seventeen feet thick; and at least three or four others in the same region, of similar dimensions, might be enumerated. Above a mile east of "Allen's Point," and on one of the highest of the elevations bordering the river, an area of several acres is so covered with huge bowlders that in places it is difficult to find a path through them; while the southern slope of the same elevation, not far removed, is so strewed with such a multitude of rounded, small bowlders that they have the appearance of having been planted artificially.

Fig. 5 represents an extremely picturesque though not a very large bowlder, on the road between Norwich and Taftville, on the lands of the Ponemah Manufacturing Company, and almost in the center of the village that has within a comparatively few years grown up about it; and which, most fortunately, has thus far been carefully protected by the company against the Vandalic spirit which is so often prompted to mutilate or destroy everything in the nature of a public curiosity.

UTILITY IN ARCHITECTURE.

By BARR FERREE.

IT is a significant commentary on the actual state of our culture that architecture, the most ancient and grandest of the arts, is to-day the least understood, the least satisfactory, the least appreciated of all the achievements of our civilization. This is the more remarkable because there are few periods so prolific of building as our own. There have been times when great and splendid works have been raised by some ambitious ruler who has produced monuments quite unlike anything that is undertaken at the present; but, while we erect no costly palaces or magnificent temples, we build thousands of smaller structures whose combined cost in any one year or term of years greatly exceeds the sums expended on the most elaborate edifices of antiquity in the same time. This is especially the case in our own country, where there is a constant and active demand for buildings of all kinds, for the most expensive as well as the cheapest, for state use and for the individual citizen. And yet, in spite of this undiminished call, which in any department of trade or of manufactures would at once produce the very best results and the most satisfactory methods, the architecture of our time is so thoroughly bad, so wanting in the first principles of common sense, so debased, that this noblest of all the arts is scarcely included in the term, and our critics speak patronizingly of it as just being "gradually recognized" as such.

Architecture has an historical chronology of at least four thousand years during which we can trace its growth, and in which it expressed in a very thorough manner the conditions under which it was developed. It has been reserved for the superior knowledge of modern times to cast it aside as one of the peculiar products of a less intelligent age, as something to admire for its past monuments, but as being quite out of our modern ideas of progress. Because in the last few years a partial revival has taken place; because it has been discovered that it offers a convenient and expensive way of impressing the beholder with the importance of the builder; because our rich men and large corporations want to give some visual evidence of their resources—it has been taken up as something that may be approved of as a means of testifying to the wealth of our cities and adding to their general good looks. The very art element of architecture has been the cause of its degradation. From the most useful of arts, it has become mostly ornamental. From meaning and expressing the utility of an edifice, it has come to refer to its appearance only. People have for-

gotten that it arose from the necessity of man for shelter, and view it as a product of the study or of the studio in which beauty and æsthetic effects are the only ends sought, while utility, convenience, expression of intention, have all become secondary considerations. Nothing could be more erroneous, nothing more fatal to the production of sound architecture.

Architecture is not the product of the imagination, but the result of experience and foresight. The painter in his studio, or the sculptor in his, has nothing to dictate to his thoughts or force them into certain channels. His fancy is free, and he allows it to carry him where it will. The architect, on the other hand, is limited by innumerable requirements and difficulties, all of which are real and physical, and all of which must be overcome before his work can be a success. His creations are not intended for the decoration of a gallery or to be preserved under glass, but they must stand the test of time and of climate, must bear a relation to the manners and customs of the day. He must exercise care and discrimination in the selection of his materials. He must count their cost and be fully acquainted with their physical properties. There is, in fact, no end to the details he must consider, in all of which there is no place or opportunity for the exercise of the imagination. His art is the product of natural conditions, and may be not inappropriately compared to a plant which, through the action of certain external elements or forces, finally assumes a character that can be directly traced to the environment, and which is, in fact, directly dependent on it.

These views are not those popularly held on the subject, but it is impossible to make an intelligent study of the history of the art without reaching them, if, indeed, they had not been already indicated by common sense. Of all the arts, architecture calls for the greatest exercise of thought; yet, strangely enough, this is the very element that is most wanting in it at the present day. All successful buildings must express an idea; they must mean something. The architecture of previous times rests on this basis, and those structures which give the most evidence of the fact are the most successful. Even in the distorted view of our day those buildings which depart from this position are the most condemned. Yet the very people who censure such lack of judgment by their ancestors do not hesitate to follow in their footsteps and produce architectural monstrosities that should never have been conceived in an intelligent age. The very rudest of African savages is fully aware of this important fact, and keeps it well in mind in building such structures as the simple needs of his life and his primitive ideas require. Thus, for example, he will build a very different edifice for a granary than he will to live in. It has been reserved for the

nineteenth century, with its great wealth, its boundless resources, and its extensive and diversified knowledge, to cast this cardinal principle to one side. Savages may, indeed, be foolish enough to build houses which exactly express the life of their builders and answer every requirement of their primitive form of existence, but we of this time are above such petty expedients, and can well afford to conform our lives to our architecture. We do not need to make our architecture conform to ourselves.

Judging from the monuments of our time, the view that architecture is not ornamentation but construction, not for beauty but for utility, not for an elaborate exterior but for a well-devised interior, not for something pleasing to look at, but for something to live in or to be put to a certain well-defined purpose, is not one that has any considerable support. A glance at a few of the chief points of architectural history will show how true this is, and to what an extent it underlies all that is good in the building art. It is characteristic of the earliest stages of society, those in which architecture had its birth, that nothing is built without a reason. Then people had too few ideas, were provided with too limited means, to be able, on the one hand, to think of unnecessary erections, or, on the other, to do more than was called for by absolute necessity. Architecture was barren of ornament, and had a crudeness that is almost repulsive to modern eyes; but, nevertheless, primitive buildings answered their purpose, as a rule, much more satisfactorily than many later ones.

Illustrations of structures in which use, not beauty, is the central idea, are to be found among the masters of art in antiquity. The Egyptians, Assyrians, Greeks, Romans, all followed this leading idea. There are, indeed, instances where the folly of a wealthy tyrant has produced an overloading of ornament, an unnecessary multiplication of details, and a striving after effect has led to the employment of bad methods; but these exceptions do not disprove the rule. On the contrary, these very structures are censured for their violation of this fundamental principle, and it is those in which it is adhered to most closely that excite our admiration and esteem.

Utility, then, being the first element of successful architecture, it follows that the structure of buildings varies according to the use to which they are to be put. This proposition is self-evident, and expresses only ordinary common sense. It would scarcely call for demonstration, were it not for the fact that many modern buildings are constructed on the basis that, if they look well, whether the outward form is suitable or not for the purpose for which they are intended, or whether the exterior expresses the interior in any way, all has been done that is required. A very different state of affairs existed in the past. The ancient Egyp-

tians, for example, adopted a totally different style of architecture for their temples or palaces than they did for their dwellings. The former were of stone, and of a massive method of building that was intended to withstand the wear and tear of ages; the latter were of wood or brick, constructed in a light manner, and without much concern as to their durability. The Romans supply another illustration of the same fact. These people were unquestionably the greatest builders the world has seen, and the methods they employed can properly serve as a guide for later usage. Much of their architecture, judged by the pure standard of the Greek, on which it largely rested, is bad from an æsthetic point of view, and not a little of their construction was devised on methods that can not always be approved of; but, apart from this, the buildings of the Romans offer many interesting examples of the application of idea to structure, and the importance of utility over mere questions of art.

It has been remarked that in ancient Rome no one ever had a doubt as to the use to which any building was put or what it was; and, in truth, great as was the variety of Roman buildings, their forms were so many, their plans so varied and so well expressed in the structure, that there never could have been room for the smallest doubt on the subject. The temple differed from the basilica, the basilica from the amphitheatre, the amphitheatre from the palace, the palace from the baths. In a word, each class of buildings had its own form, its own plan, which was based, not on some fancy of the architect, not on some individual caprice, not on some mistaken idea of the beautiful, but on the single thought that if the building answered its purpose it was satisfactory and accomplished all that was to be expected of it. In the golden age of the Roman Empire enormous sums of money were spent in adorning the capital and chief cities with public works—buildings not only for the emperor himself but for public and state use as well. The display of wealth and luxury was lavish in the extreme; ornament and decoration were to be seen in every available place in the greatest profusion; yet in the midst of all this gorgeousness the Roman architect never forgot the destination of the building. If a complicated structure, like a bath, was needed, there was no limit to the extent to which the plan was elaborated; if a simple edifice was required, such as a basilica, there was no multiplication of parts for external effect, but simply the large hall and the necessary rooms. The ornament was frequently profuse and much overdone, but the architecture proper, the structure itself, the plan, the essential part, was never anything else than what it was intended to be.

There is nothing astonishing in this method, which is only the application of common sense to art and the subordination of orna-

ment to the requirements of the time. It would not call for comment were it not that modern builders so persistently refuse to recognize it as a fundamental principle in building. Nowadays, when an architect designs a building, he is satisfied he has done all he is required to do if it looks well. If the builder of a house wants a stairway or a window in a particular place because he thinks it will be more convenient, and thereby interferes with the symmetry of the drawing that is submitted for his inspection, he is argued out of it because, forsooth, it will destroy this carefully prepared symmetry or spoil some technical gimcrack that the architect regards as his chief device; and if by chance the owner carries the day, the architect retires in chagrin, and despairs of his art ever making good progress.

No greater harm is done to the true advancement of architecture than this insistence that exterior effect is the sole end to be desired. More than any other cause it has operated to depress the art, and helped to make people question the utility of intrusting their interests to the architects. It has spread abroad the impression that these gentlemen, who might be very useful, are unnecessary luxuries, and that a much more comfortable dwelling can be built by indicating one's own desires and following one's own suggestions and views as to convenience, than by paying large sums for "pretty" façades that very likely conceal more discomfort and dissatisfaction than the most vivid imagination can conceive of in a twelvemonth. As a natural result there is a popular skepticism as to the value of professional services that not only hinders the development of a modern architecture, but does serious injury to the profession as well. Yet architects have only themselves to thank for this condition of things, and they can never hope to win the confidence of the public until they have laid aside their so-called art, and begun to design structures with the sole end of making them answer the requirements for which they are intended.

The most remarkable movement in modern architecture has been the Gothic revival, in the midst of which we are living. It has resulted in the wholesale approval of all that is mediæval, and all that bears the impress of Gothic art. It is important, not only as showing an interest in the really good work of previous times, but as indicating an appreciation for an art that is based on common sense and the adaptation of ends to means. Gothic architecture is nothing if not sensible. It originated in a time in the world's history when building was at its lowest ebb. The founders of Gothic art were possessed of limited means; they were without wealth, and their general knowledge was of the scantiest. The magnificent structures to which the Romans had been accustomed were impossible to them. Every stone counted, every item

of expenditure was rigorously scrutinized and, if not essential, cast to one side as a luxury that was unnecessary and could not be afforded. It followed, therefore, that a Gothic building had no superfluous parts, no erections intended solely for effect, nothing that was not absolutely essential. There was no unnecessary multiplication of detail; there was no attempt at a refined balance of parts or at symmetry.

Symmetrical building is the greatest bugbear that besets the modern architect, and has done more to throw him into disrepute than any other invention of the craft. The making of two parts of a building the same, whether their use was identical or not, is a very recent invention, and, though practiced by the Romans to a limited extent, was almost unknown prior to the fourteenth century. Every style has permitted more or less irregularity, according as the plan required it, and it was not until the Renaissance—a movement that is responsible for more architectural sins than is generally supposed—that the astonishing idea was presented to the world that all the corresponding parts of a building must be alike. The Egyptians, Assyrians, Greeks, Romans, and the architects of mediæval Europe, were all equally free and unsymmetrical in their designs and their methods. Even the Greeks, who produced more symmetrical buildings than any other people of antiquity, varied their designs to suit circumstances. It is needless to multiply examples, and it is sufficient to point out that this freedom from restraint, this ability to vary the design, is one of the chief glories of Gothic architecture, and helps make it applicable to the varied requirements of modern life.

Yet this very freedom militates against the use of Gothic, and is one of the reasons why it is not as satisfactory for modern requirements as it ought to be. The capability for constant variation permits the architect to compose designs of not a little beauty and almost infinite variety, which so fascinate him that in his search for a pleasing façade he forgets that the external appearance of his building may not conform to the best plan or the greatest convenience. The new Law Courts in London furnish a remarkable illustration of this. These buildings were designed by one of the leaders of the Gothic movement—Sir George Gilbert Scott—a man who was thoroughly imbued with the Gothic spirit, and who devoted his life to the propagation of Gothic forms. Yet he so far overlooked the prime element of Gothic architecture—utility—that the completed structures have been found totally unsuited for the purposes for which they were intended. It can not be wondered at that, when those to whom we look for guidance fail, there should be so many smaller failures by those not so well equipped, and who can not, therefore, be expected to have the same knowledge. There can be no surprise that there has been a revul-

sion against Gothic art, which bids fair to reach such proportions as to once more drive it out of use.

There is nothing more misunderstood at the present day than Gothic architecture. It is popularly supposed that if a building has a sloping roof, and is plentifully adorned with buttresses, pinnacles, towers, arches, balconies, dormers, and similar things, it is in the correct form of that order. Gothic architecture is, indeed, characterized by all these objects in one shape or another; but the mere placing of them in juxtaposition no more produces it than does the placing alongside of each other water, flour, and yeast make bread. It is the proper and due combination of these constituents that produces the desired result in each case. Gothic buildings have sloping roofs, because the style originated in a part of the world where the rainfall was abundant, and some device was needed to throw off the water. They have arched openings, because practical experiments in building have demonstrated that they are the most economic and safe form to use. They have buttresses and pinnacles, because they were necessary to resist the thrust of a vaulted roof. In the best Gothic not one of these forms was used unless it was an essential part of the construction. The moment one is applied to a building for ornamental purposes, or for any object other than as a necessity to its statical condition, the structure ceases to be Gothic and becomes a hybrid without a name.

Gothic architecture never employed a form that was not necessary. In this respect it offers a striking contrast to what is now called modern Gothic, which consists in applying ornament to surfaces and giving them forms which have no real meaning of their own, and are nothing more than ornamentation. A building does not become Gothic simply because it has a gable or a carved doorframe; the principle, the cause which made them Gothic in the old form, is wanting, because from parts of the structure they have become mere pieces of decoration. Gothic architecture is expressed by many forms; but its true character lies not in them, but in the application of sound constructive methods to the science of building. It is this principle that gives it a glory of its own, and it is the violation of this fundamental element which renders the Gothic architecture of the present day so unsatisfactory and so un-Gothic in spirit.

But there is another element of Gothic architecture that calls for consideration, and that is, that notwithstanding it could be varied and each part made to be exactly what it was intended to be without regard to the total effect, the results are perfectly satisfactory from an æsthetic standpoint. It shows, in a conclusive manner, that a building can be erected with the sole aim of being useful and answering exactly the requirements for which it is

designed, and at the same time be of sufficient beauty to call forth the commendation of future ages. In other words, utility in architecture is not synonymous with ugliness, nor does it follow that, because a structure is essentially useful, it is any the less beautiful. This fact is of great importance, because many modern builders have the singular idea that beauty of form and utility of structure are mutually antagonistic. The Gothic builders, for instance, employed the grandest forms and the most ambitious designs for their cathedrals; but, when they set about building a dwelling or a warehouse, kept their designs well within the limits for which they were intended. They used the same shapes, the same details, the same ideas, it is true; but the application of them is different in a dwelling from that in a church. Modern architects, on the contrary, do not hesitate to apply forms and methods that are peculiarly ecclesiastical, and which have no significance in any other connection, to domestic work; and it is no unusual thing to-day to see a castle turret decorating the corner of a thoroughfare, or a church doorway leading into a financial institution. A confusion naturally ensues as to the use of the structure, and the average spectator is frequently at a loss to know for what purpose a particular building is intended. In mediæval times such a condition would have been impossible, because then the idea that intention was the chief thing to be expressed in a structure was so firmly imbedded that any other process would never have been thought of.

It goes without saying that, if an adherence to this principle produced satisfactory results in past times, the same methods would bring about equally good ones at the present day. And yet the thought is so far forgotten as to be seldom practiced. Not all the architecture of the present time is bad, but so much of it is, that no opportunity should be neglected of hastening a reform. Our political thought is directed toward reform; we have ballot reform, civil-service reform, tariff reform, and very shortly the art world must have architectural reform, or it will be impossible to live in our houses. In place of use, we are given ornament; in place of intention, we have design. On every side buildings are criticised for their appearance, and are generally found unsatisfactory—a state of affairs that can be directly traced to their lack of ideas. Music is flat and insipid just so far as ideas are absent from it, and the same may be said of architecture. There are unrivaled opportunities for good work and plenty of it in this country, and yet there is a constant cry of dissatisfaction with the products of our architectural labor. Government architecture is as bad as that produced under private auspices. In ancient Rome it was the government's work that was the best done and has survived the longest. In the nineteenth century it is the private

work that reaches a respectable age, while that done by the government undergoes a rapid decay. The difference between the ancient and the modern method is enormous, and it needs no guide to tell which is the better. In our time, in our country at least, government architecture is considered of more importance for its effect on the "boys" than for any direct relation to the progress of art. There is no limit to the expenditures that are made on our large public buildings, but they are no sooner completed than extensive repairs are necessary that not infrequently amount to as much as the original cost.

Nothing could be worse than this, yet it is happening every day. Our streets are lined with hideous structures and comfortless dwellings. Lighting and ventilation, plumbing and heating, and all the requirements of our daily life, are sunk into subordinate positions beside the questions of external effect and the support of a large number of political hangers-on whose interest in architecture terminates with the job. It is evident that this can not be continued indefinitely. Sooner or later there will come a revulsion in public feeling, and an insistence that our architecture shall express our civilization in its fullest development, regardless of designs or exteriors. The direction in which we are working is essentially bad; and it is manifest that, if they did things better in past time, when utility was the prime consideration, the sooner we return to primitive methods the better it will be. It is a lasting disgrace to our culture that the Bushman and the Hottentot, the Indian and the Patagonian have ideas in architecture that put our own attempts to the blush and will render us a laughing stock to posterity. The instincts of animals, even, teach them ways and means of construction that are far in advance of the methods of the men of the nineteenth century. Did not the wise man say go to the ant and consider her way and be wise?

The architecture of the past teaches us many facts of interest and value, but none more important than this, that a building must express an idea. It must not seem to be what it is, but be it, without any uncertainty or doubt. In the structures now going up around us, in this land as well as in other lands, this essential element is apt to be found wanting. There are too many buildings that need repairs and alterations before they can be occupied. There are too many structures erected for external effect, without due regard to the planning and the use to which they are to be put. There is too much drawing of pretty plans and elevations on paper, without proper attention to structural requirements. There is too much haste, too much careless management, too much poor construction, too much attention to detail, too much bad taste. As a result, our buildings are bad in conception and execrable in execution. We must not condemn a build-

ing for some unpleasant detail, some crude idea. Nothing could be less proper; no building, no matter what its form, should be condemned until we know its purpose, and whether it fills it or not. The very fact that it is necessary to speak of "knowing the purpose" of a building shows how thoroughly the art has degenerated.

EDUCATION AND CRIME.

By Rev. A. W. GOULD.

IN the January number of The Popular Science Monthly there was an article by Benjamin Reece on Public Schools as affecting Crime and Vice. In that article Mr. Reece mentions the fact that "in the decade ending with 1880, population having increased thirty per cent and illiteracy only ten per cent, the number of criminals present the alarming increase of eighty-two per cent." And he asks: "Can it be possible that with greater educational facilities there is to be increased crime? Perish the thought! Yet if the instruction of our common schools subdues the tendency to crime, why is it that the ratio of prisoners, being one in every 3,442 in 1850, rose to one in every 1,647 in 1860, one in 1,021 in 1870, and one in 837 in 1880?" He tells us further that "the illiterates of the United States comprise seventeen per cent of the total population. . . . The general average of illiteracy is exceeded by every one of the original slave States with the exception of Missouri, but the average ratio of the mentally and morally unsound is only reached in the State of Maryland. South Carolina, which shows the highest percentage of illiterates, presents the lowest average of any State in the Union as regards insanity and crime"; and his conclusion is that "our condition of decreasing illiteracy and increasing crime" means that "in the adjustment of our schools we have gone too far in our aim for material advancement and development of wealth, and that we are correspondingly losing in the direction of moral growth and culture."

In other words, he thinks that the United States census proves that the increase of prisoners in our prisons is the result of the increase of pupils in our schools. And as I find that these "novel and threatening facts" have aroused some apprehension among those interested in our public-school system, it seems to me desirable that some one should point out the figures in our census which seriously modify, if not wholly destroy, Mr. Reece's alarming inference that our public schools are nurseries of crime.

Figures, like Bible-texts, may not lie, but they can be made to prove almost anything; and it would not be difficult to establish, by our census figures, the exact opposite of Mr. Reece's conclu-

sion, if we may be allowed to use the same reasoning that he does. For his statistics only show that crime and education are both increasing. But that does not prove that the increase in education is the cause of the increase in crime. Diseases have increased during the past half-century, and so has medical skill; but that does not prove that the one increase was caused by the other. Perhaps the increase of diseases would have been far greater had it not been for the increase in the power to cope with them. So education may, for aught Mr. Reece's statistics prove, be the only thing that prevents a still more rapid growth in crime.

The statistics of our last report show that the most enormous strides in developing a criminal class have been taken in those States where ignorance, and not education, most abounds. If we take the ten States that have the largest number of citizens unable to write, we shall find that from 1850 to 1880 the ratio of their prisoners has increased over fivefold, from one in 5,400 to one in 970; from 1860 to 1880 it has grown threefold, or from one in 3,600 to one in 970; while the ten States that have the fewest citizens unable to write have swelled the proportion of their criminals only threefold for the longer period and only fifty per cent for the shorter—the figures being, for 1850 one in 3,100, for 1860 one in 1,500, and for 1880 one in 1,050. So that in the States of greatest illiteracy the relative increase of criminals during the last twenty years has been six times as rapid as in the States of least illiteracy. And if we ask in what classes the most ignorance is to be found, our census tells us that the foreign-born are fifty per cent more illiterate than the natives, and the blacks seven times as illiterate as the whites; and our census tells us further that the foreign-born furnish one hundred per cent more than their share of criminals, and the blacks one hundred and fifty per cent more than their share.

Do not these facts prove that the advance in crime is the result not of education but of the absence of education? We might think so, if figures had not that reprehensible habit of being all things to all men. Therefore, we may find, upon a more careful examination, that there is some other cause than ignorance for this rapid growth of our prison population in certain parts of our country. If I am not mistaken, there are several such causes, some of them entirely independent of the change in the illiteracy of the nation. One of them lies in the transition from an unsettled condition to a settled condition on our constantly advancing frontier: another is in the change from slavery in the South; and, a third is in the gradual elevation of the standard of human conduct, making crimes of actions that had been only lawful escapades in earlier times.

The first cause comes out clearly if we compare the ten States

that were on the frontier in 1850 with ten older States—the New England and Middle States, for instance. In the former the ratio of criminals has been multiplied four or five times during the past thirty years, while in the latter it has only doubled, rising from 244 to 1,148 prisoners in a million inhabitants on the frontier, and from 450 to 1,074 on the seaboard. Of course, it is obvious that in a new country there will be a certain amount of lawless conduct unpunished at first, before sheriffs, courts, and jails are in running order. But the rapid increase in the proportion of criminals, as the State grows older, does not mean more crime; it often means less. The evil-doers are arrested and sentenced, and so get into our prisons and our census; and then we are told that crime is increasing. Kansas had only 289 prisoners to each million of inhabitants in the decade before the rebellion, while it had 1,300 to the same number in the last report; yet every one knows that this State was a far more dangerous place at the earlier time than now. Colorado had only 477 offenders per million at its first census, in 1870, but in 1880 it reported 1,950, a gain of nearly fivefold in a single decade; while on the other hand the older States, like New Hampshire and Connecticut, showed an actual decrease in percentage during these periods.

But the transition from slavery to freedom was a far more efficient cause in swelling the ratio of this class. If we compare ten of the original slave States with our ten New England and Middle States, we shall find that the increase in crime in the slave States has been three or four times as great as in the free States. The former had, for each million of population, only 161 criminals in 1850, and 240 the next decade. But in 1870 they had 829, and in 1880 1,166. This was an increase of sevenfold, while the free States only a little more than doubled their criminal element.

That this was the result of the emancipation is seen in many ways. The sudden leap shows it between the decade before and after the war, or between 1860 and 1880, if 1870 be thought too near the contest to be a fair test. Those twenty years gave a gain of fivefold in the proportion of prisoners of the Southern States, while the Northern States showed a gain of less than forty per cent. Single instances reveal it still more clearly. Mississippi sprang from 67 to 1,158 criminals in a million inhabitants, and other States of the South show nearly as great a gain; while New York and Massachusetts actually declined in their criminal percentage during that time, as did some other Northern States.

The explanation is obvious. Before the war the negroes were slaves, and nearly all their offenses were punished by their masters, so that the State had no occasion to imprison them. But now, from five to ten times as many blacks as whites, in proportion to their numbers, are found in the jails or chain-gangs of the South.

And when we remember that the greatest illiteracy is to be found in the former slave States, we see that the increase of the criminal ratio in the South may not be due wholly to ignorance, in spite of census figures. The ignorance and the crime were both there before the criminals were locked up and counted in the census.

One might, indeed, claim that the lessened ignorance had much to do with revealing this criminal element and imprisoning it. And this brings us to our third cause of the increased ratio of crime. The gradual elevation in the standard of life, and the intervention of the courts in cases which were formerly decided by the bullet or the knife, occasions a rapid increase in the official number of criminals.

Drunkenness, I suppose, was not a crime anywhere in our land half a century ago. Now drunkenness and disorderly conduct form one tenth of all the crime of the country. And naturally the restraint of these offenders will be most complete in the most orderly and educated parts of our land. Accordingly, we find that the ten educated States show a proportion of imprisonments for these offenses tenfold greater than the uneducated States do. The one has 2,865 and the other only 198 in a population three fourths as large. And the educated States record three times as many prisoners as the uneducated States for assault and battery and simple assault. If any one wishes to prove from the census that education is a failure, he could find no stronger facts than these—a tenfold larger share of drunkenness and a threefold larger share of violence in the States where men can read and write than in the States where they can not.

But, of course, no one thinks that the South is more quiet, orderly, and innocent than the North. No one believes that there was not a single case of drunkenness or disorder in all Alabama and Arkansas in 1880, and only a score of cases of assault, while Massachusetts, with a less population, had 597 cases of drunkenness and disorder and 337 cases of assault; yet this is what the census tells us. The natural interpretation must be, that drunkenness and violence are not punished by imprisonment in certain States, while they are in others, and the States that punish least are most illiterate. This interpretation is amply confirmed by the census itself. Though education shows three times the violence that ignorance does, yet ignorance perpetrates three times as many murders as education, and that, too, while two or three of the educated States imprison the murderer for life, and so swell the number, and while the illiterate States do not even think of arresting some murderers, and often acquit others who are most notoriously guilty. It was only last year that all the land heard that a certain Dr. McDow, a married man of Charleston, S. C., murdered a Captain Dawson, simply because he saved a girl whom the doctor was trying to ruin. No

one denied the murder, yet the papers tell us that the doctor was triumphantly acquitted and honored by the society of the city as a hero, instead of being counted by the census as a criminal.

And it is only in a high state of society that offenses against virtue cease to be either overlooked or avenged by violence. In this very State of South Carolina there are only four such offenders reported in prison, while Michigan has forty and Massachusetts over two hundred. The latter State, indeed, has more than all the illiterate States together. Yet, are we to think that Michigan is ten times as sinful as South Carolina, or that Massachusetts has more vice than all the ignorant States combined? McDow's case shows that such vice exists, and how it is regarded. A clergyman of the South recently asserted in the Nation—and he has not been contradicted—that only a small minority of the colored women were chaste; yet the census makes them far more virtuous than their white sisters of the North. We do, indeed, hear quite frequently of negroes being lynched for such offenses, but they obviously do not count in the census.

Therefore, though education may swell the list of criminals, there are reasons for thinking that more education and not less is what certain parts of our country need. They need more prisoners. If more men were punished for drunkenness and violence, there would be less murder. If more murderers were executed instead of being lynched or lionized, there would be less violence. It is by checking the lesser offenses that the greater offenses are avoided, though the prisons are filled thereby. And as civilization improves in the South, no doubt the proportion of men in prison will increase, at least for the present; and the whole country can not rise in its standard of moral conduct without increasing the law-breakers, especially while we have to assimilate each year such a large and often lawless element from other lands.

One of the results of raising the mass to a higher moral level is, that individuals here and there drop out; and the higher we are raised the more will drop, and this will continue till those incapable of self-control have disappeared. It is only among savages—where there is no chance to drop, because all are on the ground—that we find no criminals or paupers. And Mr. Reece actually sighs for the "perfect order" found associated with the "densest ignorance" among the cave-dwelling Veddahs and other tribes. Possibly we might attain this "perfect order" if we would imitate the savages in leading a savage life. But that would be a pretty dear price to pay for such order as savages secure.

Most of us prefer civilization with all its drawbacks. We prefer to see our country settled, though we know that jails will be

built and occupied. The very convenience of city life is paid for by added crime. The disorder that might be allowed in a wilderness among savages can not be tolerated in a crowded metropolis among civilized people. The ten States that have the largest cities punish fifty per cent more violence and sixty per cent more drunkenness than their share, though they have twenty per cent less than their proportion of murders. Petty crimes come from civilization, great crimes from barbarism. But among barbarians great crimes are called virtues, and petty crimes are unknown or unnoted.

I think, then, we need not fear that universal education is to bring us universal crime. We want more and better education. Of course, it is not the mere ability to read and write that is to save a man from prison. He must learn self-control and acquire a loftier standard of life. Mr. Reece dwells much upon the fact that a large percentage of our criminals can read and write. But that does not prove that their education made them criminals. I dare say a still larger percentage of them can see, yet it was not their ability to see that made them criminals. The densest ignorance may, like total blindness, keep men from crime; but we do not propose to put out our eyes of either mind or body. We will have men learn to see better, morally and physically. It is imperfect education that has brought men to prison, as we see from the constant relation of our criminal class to our illiterate classes. They may, indeed, have some sort of an education, but the vast majority of them are ignorant themselves, and have ignorant kindred and associates; and to be ignorant amid the civilization of to-day is to be jealous and bitter and rebellious.

The very fact that Mr. Reece cites to prove his thesis, that ignorance is innocence and knowledge crime, disproves it most completely. South Carolina, he says, has the highest percentage of illiteracy and the lowest of crime; but, if he had taken one glance below the surface, he would have seen a fact far more "novel and threatening" than any he discovered. Out of the 626 criminals of South Carolina, 570 are black and only 56 are white. Why are there ten times as many blacks as whites in jail, when they constitute only three fifths of the population? The only answer the census gives is in the fact that they are three times as illiterate as the whites. So that the very State summoned to prove that ignorance is exemption from crime, has ten elevenths of its criminals from the most ignorant class in the country. But perhaps Mr. Reece thinks that their ignorance is not quite dense enough, as one in four can still write. They certainly have not yet reached the point where ignorance is bliss.

THE AFFIRMATIVE SIDE OF AGNOSTICISM.

By JAMES A. SKILTON.

WITH LETTERS FROM HERBERT SPENCER, PROF. HUXLEY, AND DR. LYMAN ABBOTT.

IN the sacred literature of the Christian Church a word appears that to its founder and to his immediate followers evidently had a deep significance, the nature of which was at least partially concealed from his later followers, and is still concealed from those of the present day, through admitted mistranslation.

Standing on Mars' Hill and speaking to the men of Athens, Paul affirmed that in all things they were "too God-*fearing*."* Whereupon he proceeded to declare and make known unto them the God whom they worshiped as the Unknown or Agnostic God. In so doing he spoke of a God, the Lord of heaven and earth, who made the world and all things therein; who dwelt not in temples made with hands; who needed nothing, seeing he was the giver of life, breath, and all things; who had made of one blood all nations of men; and who had determined the times before appointed and the bounds of their habitation. He declared that they should seek the Lord *if haply they might feel after him and find him*, though he was constantly at hand, and the one in whom they lived and moved and had their being. He closed with a strongly put antithesis in which, without declaring divine condemnation of their agnosticism, which he said God "winked at," and they might therefore tolerate, he urged them to obey the command of God—"metanoein"—to practice metanosticism. This word has been translated to mean "repent." It is hardly sufficient to say that that translation is etymologically inadequate; the history of the Christian Church also, for eighteen centuries, proves it to be practically so. Paul evidently found in the word "metanoein" the open door of a temple in which a God-fearing worship might be exchanged for a God-loving worship. The history of his own life shows that his personal conversion was a metanostic process through which a defective external sight was exchanged for a clear insight, revealed to him as with a lightning-flash at midnight, wherein he instantly saw "the world and all things therein" in an entirely new aspect.

The question, then, indirectly presented for the consideration of the entire Christian Church, in the following correspondence, is, Whether it should adopt the word actually used by Paul, with its large meaning, either alone, as a step forward, and to restore to the sacred record and to the working power of the Church the

* The word he uses is "deisidaimonesterous," and includes the idea of devil-fearing.

true meaning of the word used by Paul, but first used by the one whom he preached and followed, as the central and supreme word in his system of salvation for the world and for mankind; or, co-operatively with science and philosophy, for the purpose of securing their powerful aid for its work in the world?

CORRESPONDENCE.

NEW YORK, *November 20, 1889.*

HERBERT SPENCER, ESQ.

DEAR SIR: I beg the privilege of presenting hereby, for your consideration and determination, a question of seemingly universal importance, that has arisen in the course of our work in the Brooklyn Ethical Association.

As far as possible I have sought to so present it as to limit your labors therein to yea, yea, or nay, nay.

The question relates to the selection and adoption of words for general use in the new philosophy, and as substitutes for the words agnostic and agnosticism, to express the affirmative side of the agnostic conception.

As a result of our experience of nearly two years in attempting to popularize evolution views, we find that just there our greatest obstacle is to be found, and our time and labor are most occupied and consumed, and increasingly so as we approach the popular mass.

The object of this communication is to propose as such affirmative substitutes the words metagnosticism and metagnostic, or metanosticism and metanostic, and to ask therefor your own approval and also that of Prof. Huxley—in concert, if possible.

My own view is that the new or substitute words involve no surrender or concession, but, on the contrary, if adopted would mark an advance in the nomenclature of the agnostic philosophy.

The accompanying statement was made by me as part of the discussion following the reading of the essay of Dr. Lewis G. Janes, on The Scope and Principles of the Evolution Philosophy, the first of the current series of the Brooklyn Ethical Association, on the evening of October 13, 1889, and it will explain itself.

I also hand you herewith a list of words and their definitions, derived or derivable from the Greek verbs *gignoskein* and *noein*, in composition with the preposition *meta*, the imperative form of which was used, according to the Greek Testament, by John the Baptist and Jesus Christ, in that passage in which they are made in the Douay Bible to say, "Do penance, for the kingdom of heaven is at hand," following the Latin Vulgate; and in King James's and later English versions, "Repent, for the kingdom of heaven is at hand."

These definitions of these words were prepared more than a year ago, at the special written request of Rev. Lyman Abbott, D. D., the pastor of Plymouth Church, Brooklyn; and the list is a copy of the first rough draft or study made in compliance with that request, but, for reasons unnecessary to explain here, has not yet been presented to him. For what use these definitions were intended by him I am neither authorized nor prepared to positively state. Dr. Abbott is in special charge of theology, liturgics, and ecclesiastical history, as editorial contributor, under the chief editorship of Prof. William D. Whitney, in the preparation of The Century Dictionary, which is an encyclopedic dictionary of the English language, now in course of publication by the Century Company, the first volume of which now lies before me. . . . In Volume I the words agnostic and agnosticism are defined at length, with references to Huxley, Romanes, and Cobbe, and to the source of the suggestion of the same by Prof. Huxley in the mention by St. Paul of the altar he had seen erected by the Athenians to the Unknown God.*

As I have previously informed you, early in his pastorship of Plymouth Church, Dr. Abbott declared his belief in the evolution philosophy, and his high sense of the value of its co-operation in the religious work of the future. He is also the editor of The Christian Union, the leading liberal religious newspaper in America. His position as such may be stated to be evangelical-liberal, or conservative-progressive, with the promise of moving faster and further, as soon as circumstances permit. Practically, things are in a ferment in all religious denominations in America at this time; or, to speak more accurately, we seem to be entering a new constructive period, and one which furnishes agnosticism and evolution their great religious opportunity.

In the statement referred to I have used the words metagnostic and metagnosticism to preserve or make parallelism in form with the words agnostic and agnosticism, to which the public eye and ear have now become accustomed, and to the better present the expressive antithesis involved therein. I am, however, fully aware that a word-form and meaning directly derived from the word metanoeite (metanoeo), which is the actual word placed in the mouth of Christ by and through the Greek original, would have certain great advantages. Prominent among them would be the ever-present evidence it would furnish that in the gospel, as actually preached by Christ and his immediate contemporaries and handed down to us, so far as we know it, the human mind was to occupy the leading place, to be elevated, and

* The authority of the Century Dictionary for this erroneous explanation of Prof. Huxley's derivation of the word "agnostic" (see letter from Prof. Huxley) was the New English Dictionary.

not degraded and disfranchised, as it has been by his alleged followers for ages past. Not only in this respect, as it seems to me, would the adoption of such a word bring science and philosophy into harmony with the true religion of Christ and nature, but it would also compel the beginning of a change in organized Christianity that would eventually bring it into complete harmony with them.

Whether the best word is metagnostic, metanostic, metagnosticism, or metanosticism, or some other form derivable directly or more remotely from the root *nous, mind*, is to me a question of minor importance. I would select that which, on the whole, is the truest and best, for the purpose of bringing about the desired reconciliation of religious with other forms of truth, even if it were necessary to manufacture the form for the occasion; and this, it seems to me, we are at liberty to do, since, strange as it may seem, while we have in our language and in frequent use all the other words derived from the kindred Greek words, the most important words of all, and the supreme words of the religion of the English race (metanoeite and metanoia), have never, apparently, up to this time, been transferred to or adopted into the English language.

The suggestion is based upon the proposition that the words to be adopted do and shall express, cover, or include the affirmative side of the terms agnostic and agnosticism. The selection of the proper forms I leave entirely to you, in co-operation with Prof. Huxley, if you approve the suggestion and think the matter worthy your and his attention.

Certainly it must, it seems to me, be considered a desirable thing to find words of affirmative import to designate the affirmative meaning hidden under the terms in present use, since it must seemingly tend to foreclose further argument and confusion on that branch of the subject.

I inclose copies of these papers to be addressed and forwarded to Prof. Huxley, if that course meets your approval.

My own plan would be, on receipt of the approval of yourself and Prof. Huxley, to bring the matter before the public, through our Association, at one of the meetings of the series now well commenced for the season, through The Popular Science Monthly, and by other means within my present reach. I am confident that recognition in the Century Dictionary would follow, and that a great impulse would be given to the new philosophy, to what would practically be a new or reformed Christian religion, in harmony with human intelligence and progress, with the express word and thought of the founder of Christianity, and calculated to combine them in the interests of the world and the race.

Very respectfully yours, JAMES A. SKILTON.

The "list" referred to included the words meta(g)nostic, nouns and adjective, meta(g)nosticism, meta(g)noiology, and meta(g)nosis. The definitions given were made approximately parallel with the definitions of the words diagnostic, prognostic, diagnosis, prognosis, etc., as found in Webster, and need not be here presented.

Monday, November 25th.

P. S.—The foregoing letter was complete on Saturday last. On Sunday, the 24th inst., by a coincidence that seems to me not to be a mere coincidence, Dr. Abbott, without any knowledge of this correspondence or my intentions, took for his subject the sermon of Paul on Mars' Hill, for the purpose of dealing with the "new doctrine" and "new thing" involved in the "new theology" now agitating the American churches. He referred to your position and that of Prof. Huxley, quoted from your writings, and practically placed himself not only in line with agnosticism as explained by you, but so near to the position I have given him in these pages that the next step must have brought out the new word. His expressed thought implied it, and I had prepared myself to hear it, when he suddenly brought his sermon to a close. I feel myself, therefore, once more justified in my statements, and am all the more anxious to use, or rather to have you use, the present opportunity. I will ask him to print the sermon, that I may send it to you in confirmation.* J. A. S.

STATEMENT.

Dr. Janes having unexpectedly and without suggestion of mine used my name in connection with the term "metagnosticism," I feel compelled to make my use of it as clear as possible at once, without waiting another occasion.

The doctor chooses his words with exceeding skill and care. He says that he will endeavor, in defining philosophical agnosticism, to show that "in every department of scientific, historical, and true philosophic investigation, indeed, it is consistent and coincident with the meta-gnosticism of his friend Mr. Skilton." †

As so limited—to the definition of philosophical agnosticism—the statement and the subsequent showing are both entirely satisfactory. But the limitation is not so.

As adopted and used by me, the term meta-gnosticism has a much larger meaning, and has an important bearing not only upon science, history, and philosophy, but also upon and in re-

* The substance of the sermon is embodied in an article in the Forum for April, 1890.

† For a discussion of meta(g)nosticism in relation to the evolution of society, see Evolution—Popular Lectures and Discussions, before the Brooklyn Ethical Association, pp. 216–227.

ligion, meaning the religion of our civilization, as well as the religion of evolution and the future.

The evidence is abundant that even in the domains of science and philosophy the word agnosticism does not and can not express in full the idea or system for which it stands representative. Mr. Huxley, the inventor of it, is, as we all know, in a state of constant warfare over it; and as to Mr. Spencer, it is sufficient to refer to his controversy with Frederic Harrison and his "x^n" as the appropriate symbol "for the religion of the Infinite Unknowable."

With both of these men—the acknowledged leaders among agnostics—and with all their followers, the trouble is that at present they are compelled to seek to accomplish the practically impossible by attempting to read a positive and affirmative meaning into a word that is and can be only indefinite and negative. And the words meta-gnosticism and meta-gnostic are proposed for the purpose of meeting precisely that difficulty, and for the reason that they are positive and affirmative.

Mr. Huxley really found the word agnostic, or its root, already in use in the Greek language, and borrowed and used it for the want of a better one, little thinking, doubtless, how important it would become. It is believed that the time has now arrived for importing another word, cognate in origin and affirmative in meaning, into our language, if it be found by competent authority to meet the requirements of the case.

In his essay entitled Retrogressive Religion, in reply to Harrison, Spencer says (p. 68, Appletons' edition):

"I might enlarge on the fact that, though the name Agnosticism fitly expresses the confessed inability to know or conceive the nature of the Power manifested through phenomena, it fails to indicate the confessed ability to recognize the existence of that Power as of all things the most certain. I might make clear the contrast between that Comtean Agnosticism which says that 'theology and ontology alike end in the Everlasting No with which Science confronts all their assertions,' and the Agnosticism set forth in First Principles, which, along with its denials, emphatically utters an Everlasting Yes. And I might show in detail that Mr. Harrison is wrong in implying that Agnosticism, as I hold it, is anything more than silent with respect to the question of personality; since, though the attributes of personality, as we know it, can not be conceived by us as attributes of the Unknown Cause of things, yet 'duty requires us neither to affirm nor deny personality,' but 'to submit ourselves with all humility to the established limits of our intelligence' in the conviction that the choice is not 'between personality and something lower than personality,' but 'between personality and some-

thing higher,' and that 'the Ultimate Power is no more representable in terms of human consciousness than human consciousness is representable in terms of a plant's functions.'" And again (p. 66, id.): "Whereas, in common with his teacher Sir William Hamilton, Dean Mansel alleged that our consciousness of the Absolute is merely 'a negation of conceivability'; I have, over a space of ten pages, contended that our consciousness of the Absolute is not negative but positive, and is the one indestructible element of consciousness 'which persists at all times, under all circumstances, and can not cease until consciousness ceases'—have argued that while the Power which transcends phenomena can not be brought within the forms of our finite thought, yet that, as being a necessary datum of every thought, belief in its existence has, among our beliefs, the highest validity of any: is not, as Sir W. Hamilton alleges, a belief with which we are supernaturally 'inspired,' but is a normal deliverance of consciousness."

These quotations are sufficient to show that, as he holds it, there is a positive and affirmative side to the doctrine of the Unknowable, or to agnosticism, as taught by Mr. Spencer; and also that there is occasion for a word or words to express it.

In his article Agnosticism, published in The Popular Science Monthly for April, 1889, Prof. Huxley says:

"Agnosticism, in fact, is not a creed, but a method, the essence of which lies in the rigorous application of a single principle. That principle is of great antiquity; it is as old as Socrates; as old as the writer who said, 'Try all things, hold fast by that which is good'; it is the foundation of the Reformation, which simply illustrated the axiom that every man should be able to give a reason for the faith that is in him; it is the great principle of Descartes; it is the fundamental axiom of modern science. Positively, the principle may be expressed: In matters of the intellect, follow your reason as far as it will take you, without regard to any other consideration. And negatively: In matters of the intellect, do not pretend that conclusions are certain which are not demonstrated or demonstrable. That I take to be the agnostic faith, which, if a man keep whole and undefiled, he shall not be ashamed to look the universe in the face, whatever the future may have in store for him.

"The results of the working out of the agnostic principle will vary according to individual knowledge and capacity, and according to the general condition of science. That which is unproved to-day may be proved, by the help of new discoveries, to-morrow. The only negative fixed points will be those negations which flow from the demonstrable limitation of our faculties. And the only obligation accepted is to have the mind always open to conviction."

In view of such utterances—and of many similar ones in other writings of both Spencer and Huxley—it seems that a positive and affirmative word, or set of words, capable of expressing the agnostic idea, if to be found or framed, would not only be applicable, but would be acceptable to them and fit for the system of thought with which the essay of the evening is concerned.

The words proposed come from the same root as the words gnostic, agnostic, prognostic, and diagnostic.

The root is verbal and affirmative. It means to know; and with the prefix meta, means to know beyond. The noun means beyond-knowledge. Beyond-knowledge may be knowledge "beyond the sphere of sense," and correspond to Spencer's definition of religion, or, as you will, it may refer to all knowledge beyond mere sense-perception, and so include all human knowledge that exceeds that of the brute animal and is derived from or limited by the senses. As for myself, I prefer the total meaning: for then, as the civil engineer uses his base-line and two known angles to measure distances and relations of things beyond the river where he can not go with his tape-line, and the astronomer the distances, actual and relative, of the heavenly bodies, so we may use our actual hither-knowledge for the purpose of dealing with the field of beyond-knowledge—or of the Unknowable—where the senses can give us no direct aid.

As to the appropriateness of the adoption of the proposed words into the English nomenclature of religion, the evidence at hand is still more authoritative and conclusive than in the case of science and philosophy.

In his preceding essay—Religion: A Retrospect and a Prospect—Mr. Spencer begins with these words:

"Unlike the ordinary consciousness, the religious consciousness is concerned with that which lies *beyond the sphere of sense.* A brute thinks only of things which can be touched, seen, heard, tasted, etc.; and the like is true of the untaught child, the deaf-mute, and the lowest savage. But the developing man has thoughts about existences which he regards as usually intangible, inaudible, invisible; and yet which he regards as operative upon him."

If you ask the source from which the proposed words are derived, the reply is that, as to the second form, it is found in the New Testament, and is the supreme word in the messages of John the Baptist, of St. Paul, of Jesus Christ, and of the gospel generally, wherein it is believed truly to have the precise meaning—as shown by the context—of the proposed English word or words under discussion; and that, as to the first form, it is constructed by throwing out the prefix—a—from the word agnosticism, and substituting the prefix—meta.

Prof. Huxley, the inventor of the word agnostic, is said to

have derived it from St. Paul's mention of the Unknown or Agnostic God. The word now suggested is derived from the substitute proposed by St. Paul at the same time. While St. Paul did not advise the Athenians to erect an altar to the metanostic God in place of the altar they had erected to the Agnostic God, he used the word metanoein, and he thereby clearly advocated the practice of what we may properly call metanosticism as the alternative and substitute for agnosticism, in connection with religion and its observances. This he did after expressly declaring the absence of any divine condemnation of their agnosticism, which God is said to have "winked at" or overlooked. The strong and suggestive antithesis made use of by St. Paul has been lost in the translations of the language employed by him on that occasion; but there is no time to enlarge, here and now, upon the fraudulent travesty practiced upon mankind for ages by the Church in translating the original word so used to mean "do penance" and "repent."

I content myself with asking, What would be the consequences of the candid, common, and proper acceptance and use, throughout the civilized world, of such a word to express the central thought of the science, the philosophy, and the religion of our age and of the ages to come, sanctioned by the high priests of each of these departments of thought?

I have only a word to add: Without committing this Association, as its corresponding secretary, or otherwise, or any other person but myself, to the proposition, it is my purpose to submit the question of the adoption of the words meta-gnostic and meta-gnosticism, or metanostic and metanosticism, as affirmative substitutes for the words agnostic or agnosticism, to Mr. Spencer and Mr. Huxley, in the hope that, as leaders in modern agnostic thought, they will see their way clear to their adoption, and thereby supply a link to unite science, philosophy, and a true Christian religion in behalf of humanity and future ages.

And when their replies are received—if so be—they will be communicated to this Association for its further consideration, and possibly for its co-operative action.

LETTER OF HERBERT SPENCER.

64 AVENUE ROAD, REGENT'S PARK, LONDON, N. W., *December 22, 1889.*

MY DEAR SIR: I have to thank you for the volume of Evolution lectures, which I received recently. I presumed that they would eventually be bound together, and that you would kindly send me a copy. This, of course, I shall like to keep.

Will you excuse me if I do not go into the matters raised by your late letters? I have been made so ill by over-excitement that until Wednesday last I had not been out for more than a

month, and, though I am now better, I must avoid every mental tax, however small.

I did not receive the journal which you named in your last, containing some matter respecting Dr. Abbott's address (I think it was). Very truly yours,

HERBERT SPENCER.

J. A. SKILTON, Esq.

LETTER OF PROFESSOR HUXLEY.

EASTBOURNE, ENGLAND, *December 10, 1889.*

DEAR SIR: I have read the papers which accompanied your letter of the 25th of November with much attention; but, I regret to say, with the result that I can discover no good ground for the change of nomenclature which you propose. Permit me to trouble you with my reasons for that conclusion:

The term "Agnostic" was not suggested by the passage in the "Acts of the Apostles" in which Paul speaks of an inscription to the "Unknown God" (ἀγνώστῳ θεῷ). It is obvious that the author of that inscription was a theist—I may say an anxious theist—who desired not to offend any God, not known to him, by ignoring the existence of such a deity. The person who erected the altar was, therefore, in the same position as those philosophers who, in modern times, have brought about the apotheosis of ignorance under the name of the "Absolute" or its equivalents.

"Agnostic" came into my mind as a fit antithesis to "Gnostic"—the "Gnostics" being those ancient heretics who professed to know most about those very things of which I am quite sure I know nothing.

"Agnostic," therefore, as the name of a philosophical system is senseless; its import lies in being a confession of ignorance—a warning set up against philosophical and theological phantoms—which was never more needed than at the present time, when the ghost of the "Absolute" slain by my masters Hume and Kant and Hamilton is making its appearance in broad daylight.

Your definition of "metagnosticism" says that it "relates to beyond-knowledge." That is exactly what all the "absolute" philosophers profess the "Absolute" does; and it is precisely that profession which I consider to be futile and mischievous. To my mind science is exact and organized knowledge—neither more nor less. And the knowledge which goes "beyond knowledge" is something which my cognitive faculties do not enable me to apprehend.

The term "Evolution Philosophy" which you employ seems to have different meanings for different people.

For me, evolution is a name for a certain process, the occurrence of which in various groups of things is as nearly demonstrated as any historical event can be. And this, I think, consti-

tutes a fair ground for the expectation that the whole cosmic process will turn out to be one of evolution. The business of philosophy, as I understand it, is, among other things, to arrive at a scientific theory of evolution; but these other things are quite as important as evolution. Philosophy, in fact, should embrace the whole of which the theory of evolution is a part.

Three or four generations of patient workers, cautiously feeling their way by the well-known methods of true science, may bring our posterity within sight of such a philosophy. For the present, while welcoming all attempts to foreshadow it, with due gratitude to their authors, and holding fast by that which is good in them, it is very necessary that we should not confound such scaffoldings with the edifice, the foundations of which are not yet complete. I am, dear sir, yours very faithfully,

T. H. HUXLEY.

JAMES A. SKILTON, Esq.

Prof. Huxley asks that the foregoing letter be made public, on the ground that "there seems to be a good deal of misconception as to the position which now (as always) (he) I hold(s) in respect of current philosophical speculations."

LETTER OF REV. LYMAN ABBOTT, D. D.

PLYMOUTH CHURCH, BROOKLYN, *April 22, 1890.*

MY DEAR MR. SKILTON: There are two distinct questions raised in this correspondence, one an etymological, the other a philosophical one: the first relates to the use of language, the second to the limits of knowledge; the first is as to the meaning of a word, the second as to the powers of the mind.

I. *Metanoëo* is composed of two Greek words, *noëo*, to think, and *meta*. Now *meta*, in composition, appears to imply one of three things: either (1) fellowship, as in *meta-didōmi*, to give to or share *with* another; or (2) exchange, as in *metallassō*, to change *with* another, to exchange; or (3) sequence, as in *meta-melomai*, to care *afterward*, to regret. I can not find that *meta* ever signifies *beyond*. The preposition used for this purpose is *huper*. Thus we have *huperekperissou*, exceeding abundantly, literally *beyond measure*. It would seem, therefore, according to the analogy of language, if the New Testament writers had wished to coin a word to express the idea of knowledge beyond knowledge, the word would have been not *meta-noia*, but *huper-noia*.

It is, however, very clear that the word *repent* does not correctly represent the meaning of the Greek word *meta-noeō*, if we have regard to the etymologies of the two words. *Repent* is strictly to repunish, and this is the idea which the Latin mis-

translation has carried into the New Testament teaching. We have, as a consequence, the popular idea, that the first step in a religious life is self-inflicted punishment for past sin; an idea which gave rise in the middle ages to the elaborate system of voluntary penances, fasting, flagellations, etc., and, more spiritually interpreted, to the still common idea that no man can begin a Christian life without first undergoing what is called a "conviction of sin"—that is, a sense of shame and sorrow more or less poignant because of sin. This misconception—for I am sure that it is a misconception—leads modern revivalists to endeavor, by various rhetorical and dramatic devices, to create such a feeling of sorrow; and would-be converts to endeavor, co-operating with them, to beget in themselves such an experience. And conversion is thought to be, or at least to be attested by, a sudden emotional change from such an experience of regret and remorse to one of peace and joy. This endeavor is scarcely more consistent with the true teaching of the New Testament than the grosser and more material endeavor to inflict self-punishment for sin by penance. The flagellation of the soul is not more scriptural than the flagellation of the body. What the Bible calls on men to do is not to repent—that is, to punish themselves—but to "change their minds," that is, to change their aims and purposes and habits of thought and inward life. We have no English equivalent, so far as I know, for the Greek words *meta-noeō* and *meta-noia;* the phrase "change of mind" expresses an idea quite too superficial. A change of the whole attitude of the soul toward life is indicated. This may, and I think does, involve looking beyond the sphere of sense; it involves a perception of something that is beyond knowledge; but this is rather psychologically involved in the mental condition than etymologically involved in the Greek word *meta-noeō.*

II. In respect to the psychological question, it is hardly necessary for me to do more than say that I am in entire agreement with you, and with what seems to me to be clearly involved if not explicitly stated in what you have quoted from Herbert Spencer. Scientific knowledge—truth that is scientifically demonstrable—is derived by logical processes from observed phenomena. This scientific process makes it reasonable to believe as a probable hypothesis that there is a psychic life which the decay of the physical organization does not destroy; but what is the nature of that life, and whether it preserves its individuality, or is absorbed into the general psychic force of the universe to reappear in new forms, are questions on which the scientific process throws little or no light. So the scientific process makes it as absolutely certain as anything can be that "we are ever in the presence of an Infinite and Eternal Energy from which all things proceed." But

it is far from making certain what is the nature of this Energy, which is scientifically as unknowable as the inherent nature of matter or of force. But there is a knowledge beyond knowledge; that is, a knowledge of truths which are not ascertained by logical processes from observed phenomena, and are not, therefore, demonstrable by logical processes from observed phenomena. We know all æsthetic, all ethical, all spiritual truths by other means than scientific processes. Into these truths we come by looking beyond the sphere of sense; by looking beyond the larger domain of logical deduction; by æsthetic, moral, spiritual perception. We know that God is, because we commune with him as a personal friend and he is "nearer than breathing, closer than hands and feet"; we know that we are immortal—not shall be—because we have in ourselves a consciousness of life which physical pain and decay can not injure or impair. Thus our faith may be truthfully described as a knowledge beyond knowledge; but it is not any less certain and trustworthy because it transcends scientific tests and demonstrations.

I hope I have given a definite and tolerably clear answer to what seem to me to be the two questions implied in your correspondence. There is a knowledge beyond knowledge. The error of agnosticism is not in its denials; it is in its psychology; it is in the fact that it ignores a part and that the larger and more important part of man's mentality—his power to perceive directly and immediately a world not cognizable, directly or indirectly, by the senses; that power which alone makes him a being of taste, of affections, of moral or spiritual capacity. The answer to agnosticism is not in maintaining that by the scientific process we can arrive at certainty concerning truths which are not scientific; it is by a recognition of what you have called *meta-nosticism*, the power of grasping knowledge beyond knowledge; though the word *meta-nosticism*, at least in so far as Scripture use is relied on for its meaning, hardly conveys, it appears to me, though it does imply, the idea which you purpose it shall convey in the future.

Yours sincerely,

LYMAN ABBOTT.

CONCLUDING REMARKS.

Dealing with the uncorrected mistranslations of the New Version, Rev. Treadwell Walden says: *

> It may now be imagined with what interest and expectation we looked forward to the New Version, realizing full well the difficulty of reproducing the original in this place and elsewhere more faithfully, and of making a change so

* An Undeveloped Chapter in the Life of Christ. The Great Meaning of the Word Metanoia, lost in the Old Version, unrecovered in the New, pp. 14, 17, 18, 38, 39.

startling, but hoping that, *at the least*, a marginal rendering would indicate the literal alternative, or a glossarial note define the Greek expression in a way that would go far to correct the English one. But the revision flows on, making a ripple of change in almost every verse, yet with not a sign of perturbation over this sunken rock. Neither a light-ship nor a buoy warns of a spot where there has been shipwreck before now.

We understand, however, that it was the subject of discussion among the revisers, and that the matter was finally passed by, not because the present rendering was satisfactory, but because no *one* equivalent English word could be found comprehensive enough for the purpose. What, then, has been so long lost in the Old Version, remains unrecovered in the New, because of a reluctance to employ a paraphrase! The poverty of our language, in this respect, is to keep *us* poor. Or, it may be, something else was at the bottom of it, symptoms of which are apparent in other instances. It may have been the reluctance of that kind of conservatism which prefers not to disturb traditional notions or long-established formularies. We comfort ourselves, however, with the thought that the New Version is not a finality, but only tentative to that which shall yet meet the brave demand of the nineteenth century. What we have is a bold and noble move, but the whole of English Christendom are in council over it now, and suggestions and criticisms will flow in for some years to come; changes of view will also take place, making the way clearer and easier to a more fearless and absolute transfer of the original into our native tongue.

It were a bold word from any but a Divine mouth—we should say—and yet the human tongue has been uttering it, virtually, all along in another sphere. What has been the proclamation of science in its own material world, but "Metanoeite? Change your mind from the near testimony of Sense to the distant witness of Discovery"? Sense says: The sun rises in the east and revolves about the earth; the earth is the center of the celestial sphere. But Science—knowledge—proclaims a contradiction, and, with it, a revolution. It is the earth that goes round the sun, the sun is but one of that starry host, the blue firmament melts into illimitable space; it is an illuminated universe which lies out there, in which this apparently ponderous globe floats like an atom in a sunbeam. So Science, an echo of the divine voice, has enlarged, reversed the whole consciousness of man. Her metanoia has been proclaimed, not only here, but everywhere in her material field. Whithersoever she has gone, Nature has inverted its apparent order, its phenomena have widened out into once occult principles, and the first human impression of them has had to be revoked.

We can now imagine how, under such a conception, the pulpit would awake to the grandeur of its work, how the Church would awake to the grandeur of her cause. The themes of the one, the methods of the other, would move with splendor and with power to one definite and mighty end—the summoning of mankind to the metanoia, this new mind, and the announcement of *everything* on the divine side of life, which would inspire and create it. For we are just on the verge of a great epoch. All this intellectual activity in the material world is surely working toward a moment of reaction when the same intensity of movement will turn the other way, and the universal demand will be for a knowledge of the spiritual. The voice of Science, crying in its wilderness, will be found to have been preparing the way to this. It will turn out to be the "expectation" of this age. Out of its dust and ashes shall mount again the cry: "Metanoeite! for the kingdom of heaven is at hand!" Let us see to it that neither the Bible, the Church, nor the pulpit, gives *then* an uncertain sound.

Mr. Walden also quotes De Quincey as saying:

In my opinion the Greek word metanoia concealed a most profound meaning—a meaning of prodigious compass—which bore no allusion to any ideas whatever of repentance. The *meta* carried with it an emphatic expression of its original idea—the idea of transfer, of translation—or, if we prefer a Grecian to a Roman appareling, the idea of a *metamorphosis.* And this idea, to what is it applied? Upon what object is the idea of spiritual transfiguration made to bear? Simply upon the *noetic* or intellectual faculty—the faculty of shaping and conceiving things under their true relations. The holy herald of Christ, and Christ himself, the finisher of prophecy, made proclamation alike of the same mysterious summons, as a baptism or rite of initiation, namely, Μετανοεῖτε—henceforth transfigure your theory of moral truth; the old theory is laid aside as infinitely insufficient; a new and spiritual revelation is established. Metanoeite! Contemplate moral truth as radiating from a new center; apprehend it under transfigured relations.

No exhibition of blank power—not the arresting of the earth's motion—not the calling back of the dead to life, can approach in grandeur to this miracle which we daily behold—namely, the inconceivable mystery of having written and sculptured upon the tablets of man's heart a new code of moral distinctions, all modifying—many reversing—the old ones. What would have been thought of any prophet, if he should have promised to transfigure the celestial mechanics; if he had said: I will create a new pole-star, a new zodiac, and new laws of gravitation; briefly, I will make a new earth and new heavens? And yet a thousand times more awful it was to undertake the writing of new laws upon the spiritual conscience of man. Metanoeite! (was the cry from the wilderness). Wheel into a new center your moral system—*geocentric* has that system been up to this hour—that is, having earth and the earthly for its starting-point; henceforth make it *heliocentric* (that is, with the sun, or the heavenly, for the principle of motion).

In an appendix Mr. Walden also prints an extract from a letter of Rev. Philip Schaff, D. D., in which the latter expresses "cordial approval" of the "able, excellent, and truthful article on the meaning of *metanoia*," and states that "conservatism prevented a change, and the difficulty of substituting a precise equivalent word," doubtless referring to the proper substitute in the new version for the word "repentance."

Attention may here be called to the fact that Hamilton says, "I would employ the word *noetic* to express all those cognitions which originate in the mind itself." Why not rather employ the words *metanoetic* or *metagnostic* for that purpose? It is to be remembered also that Lewes, in the Foundations of a Creed, says that he found it necessary to invent the new word *metempirical*, to "clearly designate" the "province where sense has no footing, where experiment can exercise no control, and where calculation ends in impossible quantities," the region of the "supersensible"; and to distinguish it from the province of the empirical, the region of the sensible and the extrasensible. But that word does not seem to have been generally accepted, and is not adequate for our purpose.

It appears, then, from an examination of the accompanying correspondence and quotations, that in two of the most important provinces of human thought, religion and philosophy, there is no proper and accepted English word to designate the supreme principle and element of the systems; that the universally accepted word to designate the same in one of them is, and for many years has been, known to be utterly insufficient if not false, by many among the leaders, and that in the other province such a word is much to be desired.

It is no part of our purpose to discuss the appalling disclosure of an only plan of salvation offered to the world, and yet concealed from it for ages of agony through want of a word by which to make it known; nor to discuss the effects of that disclosure upon the "common people" when it shall be finally made clear to them. After the publication of this article it can no longer be said that no attempt has been made to supply the missing word, and it will be for those whose function it is to decide such matters either to slowly adopt it, to supply a better, or to allow us to drift without it. But at this moment the word here proposed as adequate, and advocated as especially fit in view of its tendency to unite and harmonize both domains of human thought, interest, and activity concerned, has not been accepted by the leading authorities of either religion or philosophy, so far as it has been submitted to them.

However, Dr. Abbott seems to admit that, etymologically, philosophically, and scripturally, the proposed word implies, if it does not convey, the desired meaning.

As to the suggested word *hupernoia*, the fact that the preposition *huper* was not used in the New Testament becomes a striking negative argument in favor of our word. Moreover, *huper* evidently relates to quantity or proportion, and means excess, while *meta* relates to space or position, and means universally—according to Webster—in composition, beyond, over, after, etc.

Much remains to be said, but enough has already been said to open the discussion of the subject, and to put the responsibilities of the situation upon the leaders of religious and philosophic thought, to whom they properly belong.

THE objects of anthropometry, according to Mr. Francis Galton, are to define the individual or the race, and to show in what way and to what extent he or it differs from the others. By taking measurements the individual is taught to know his own relative powers at any given time, and we are helped to watch over the development during the period of growth, and to give it direction if it does not proceed normally. Measurements of the head are designed to show how much and up to what age the brain continues to grow, and to aid in comparing the educated with the uneducated classes.

TIN AND ITS NATIVE LAND.

By M. BRAU DE SAINT POL LIAS.

TIN, which every one knows, but which few, except men of science and metallurgists, are acquainted with, is one of the most precious and most interesting metals. After gold and silver, it is intrinsically the most precious of those in use. It is nearly of the same color and almost as bright as silver, but has less resistance and is less valuable. When warmed by friction, it has a pronounced odor and taste. When it is bent, the derangement of the crystals of which its mass is formed causes it, without any fracture taking place, to emit a peculiar sound which metallurgists call its cry, and by means of which an expert can nearly determine its degree of purity. The places where tin is produced are few, scattered sparsely over the surface of the globe; and it disguises itself under the form of a blackish mineral which, to the profane eye, gives no sign of the treasure that is within it.

One of the richest as well as most ancient tin mining districts is in the Malay Peninsula, the Golden Chersonesus of the ancients. The name of the province, Pérak, signifies silver; but it is peculiarly the province of tin. A few years ago we visited the mines there, ascending the Larrout River in a Chinese junk to Telok-Kartang, where a warm reception awaited us from the English colonial authorities. Thence we went, in a country wagon, and afoot after it had broken down, through a country where tigers are not rare, to Thaïping, the principal town in the district. We found lodging in the house of the assistant resident on the top of the Boukit Bandéra, which appeared to our eyes at the moment a veritable castle of the fairy tales. Opening the window in the morning, we could look from our elevated position upon the country of tin, which lay in nearly its full extent before us. Large mounds of white earth and water-holes of strange form, breaking up the surface at different points around the *kampang*, marked where mines had been worked or were still in working. Chinese coolies were climbing up and down the notched tree-trunks which served as ladders to the open pits, bearing on their shoulders bamboos, at each end of which hung the baskets in which the mineral was carried. Hydraulic wheels, which were nothing but primitive wooden Archimedes' screws, or *norias* with inclined buckets, were turning with harsh creakings, lifting the water out of the bottom of the excavations. Animation prevailed over the whole plain, in which were to be seen by turns arid spots of mineral refuse, or exuberant tropical vegetation. Farther on the country grew hilly, and the view was at last shut off by a semicircle of high mountains, in which are found the true mines, in quartz

veins charged with tin, intersecting the granitic masses. The washings of these veins, mingled with alluvial sands, have been carried down by the rivers and spread by them through the floods of the ages over the bottom-lands of the country. Taking advantage of this work of Nature, man, instead of quarrying in the mountain for the vein and having to blast the incasing rock, has only to look in the flats for the mineral.

The mines were worked by the Chinese, no European operator having been as yet established in the country. It did not take long to witness the extremely simple process by which the ore is

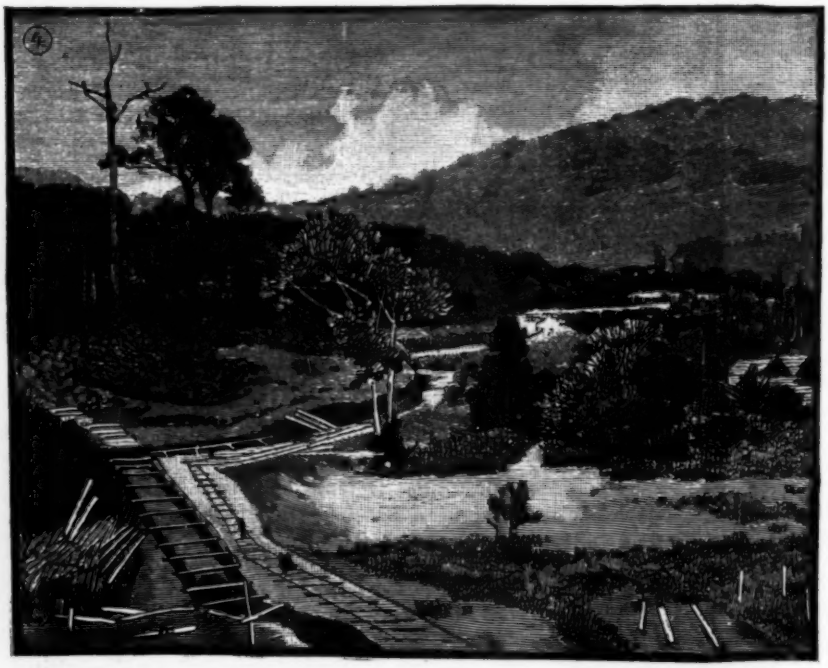

FIG. 1.—SUNGEI LEMBING TIN-MINING DISTRICT, PENINSULA OF MALACCA.*

extracted. After clearing off the ground, the surface and subsoil are removed for one, two, or three metres, till the mineral, tin-bearing bed is exposed; this is sometimes several metres thick. The mineral is carried in baskets, as we have seen, up the cocoa-trunk ladders, to a wooden flume which is washed by a current of water. As the mine grows deeper this labor, with the rudimentary means at the disposition of the Chinese, is made extremely difficult by the inflow of water. The washing of the tin-bearing earth is done by coolies, who with a rake remove the stones and

* The illustrations in this article are views in the lands of the British "Pahang Corporation," which has been formed to work the mines in Pahang, eastern Malacca.

work up the material in such a way as to eliminate the light sands that are mixed with oxide of tin, till only twenty-five or thirty-five per cent of foreign matter is left. The mineral thus enriched is melted in little brick furnaces, with the aid of a bellows of bamboo, which is worked by a coolie as if it were a syringe. The white metal as it runs out is cast into the well-known cubic ingots with one side flaring over the edges, so as to give them a pair of ears by which they can be more easily handled. A great deal of metal is certainly wasted in this process; and a second washing of the refuse would probably be very remunerative. The Chinese and Malays call this lost metal young tin, which is returned to the earth to ripen, because it is not yet old enough to stay in their primitive machines. It is only now, after no one can tell how many centuries since tin has been known and worked in the peninsula, that a rational system of operating the mines is about to be adopted.

The use of tin dates from extreme antiquity. Homer mentions it as *kassiteros*, in the descriptions of the arms of his heroes. Herodotus speaks of the British Islands as the *kassiterides*. The Phœnicians obtained the tin which they furnished to the ancient world chiefly from those islands, but partly also from Gaul and the Iberian Peninsula. Before the Phœnicians and the Greeks, however, the Chaldeans knew this metal under the name of *kastira*. The most ancient document in which a mention of it has been found is probably a hymn to the fire, which M. Oppert has translated from the Accadian language, a tongue the knowledge of which has been recently revived from cuneiform documents. Tin was designated in them, five thousand years ago, as *anaku*. The biblical text in the Book of Numbers, in which Moses names tin in the enumeration of the metals, is therefore comparatively modern, for it is of fifteen hundred years later date than the hymn to the fire. Even more definite than these texts is an Egyptian statuette in bronze (an alloy of tin) of the age of the pyramids, or 3600 years B. C.

FIG. 2.—NATIVE CHINESE TIN-STAMPING MILL ON THE KUANTAN, MALACCA.

Let us return to our own age, and see what is the present annual production of tin. In a recent book on the Industries of the Netherlands, M. de Ramaix gives as the production of the Dutch East Indies, ten thousand tons; of Cornwall, eight thousand tons; and of Australia, seven thousand tons; in all, twenty-five thousand tons. These figures show that the English mines have fallen off since the days of the Phœnicians, when Cornwall was the principal center of production. They have been left behind by the Dutch East Indies, and will soon be overtaken by Australia, if the number, seven thousand tons, given as the present production of its mines, is not exaggerated. Saxony and Bohemia, which still figure in the cyclopædias as sources of tin, are not mentioned in M. de Ramaix's estimate. A graver omission is that of the Malaccan mines, which I have mentioned as the most ancient, and also perhaps the most productive. According to Mr. Patrick Doyle's Tin-Mining in Larut (London, 1879) the Malay states of the Malaccan Peninsula exported to Penang in 1877, in round numbers, 2,500 tons of tin, and the Siamese states of the same country, 7,000 tons, making 9,500 tons in all. From personal information, I estimate the exportation from the single Malay state of Pérak, in 1881, at 6,139 tons. The production of the peninsula having grown steadily since 1876, I believe I can assert that it now takes the lead among tin-producing countries, and that the world's total present annual production of this metal is not less than 45,000 tons.*

Yet this production is hardly sufficient to supply the needs of existing industry, for the price of tin before the crash in copper, by which it was also affected, had reached the high figure of $800 a ton. This is because, while the applications of the metal have varied much at different periods, it has always been applied to numerous uses. There is hardly a house so humble that has not its utensils of tin-ware. Wherever woman has advanced beyond the crystal of the fountains, of which Seneca boasts, we are sure to find, if not a looking-glass, a mirror; and there is hardly a country so savage that European glasses silvered with the amalgam of tin have not reached it. It is used in all the applications of soldering, in tin-foil for wrapping preserved foods, and in printing-types. Some of the uses which our forefathers made of it are matters of much interest.

In the middle ages tin passed from the Gauls to the Merovingian Franks; and, according to Gregory of Tours, basilicas were roofed and tombs were covered with it. It was extensively used

* I believe that these figures understate the facts. In a book on the Political Geography and Economical Situation of the Malay Peninsula, in 1888, published by the French Minister of Public Instruction, M. de La Croix gives the production of the peninsula, from official documents, as over 24,000 tons, or more than half that of the entire globe.

in convents and churches, where devotional objects of every kind were made out of it—crosses, chandeliers, holy-water bowls, other vessels, organ-pipes, and pilgrim-standards. It was allowed, with gold and silver, to enter into the composition of the sacred vessels, when wood, lead, copper, and bronze were prohibited as base or insalubrious, and glass on account of its fragility.

Bishops and priests were buried with their symbols, crosses, and chalices represented in tin. This metal served well in place of silver in the illumination of ancient manuscripts, as it now takes the place of gold in the lacquers of China and Tonquin, in which the metallic luster of tin-foil has given the transparent varnish the yellow shine of gold. Some objects found in the Italian tombs have an interesting resemblance to those of Tonquin and China. Curiously, the custom of the Chinese and Anamites, of burning papers to their ancestors bearing the figures of objects which they use while living, finds its equivalent among the peoples of Europe, who placed in the tombs of their dead tin images of similar objects, such as forks, knives, tongs, tripods, and candlesticks.

Tin was likewise employed for numerous purposes, often exalted ones, in the life of the middle ages. The ceremonial cups in which the wine was formally offered to a sovereign or to a lord making a solemn entry into a city, and the goblets given as prizes to the most adroit bowmen, were usually made of it. So were cups and measures for wine and oil, porringers, and dishes of all sizes. Plates came later. This piece, which it seems to us so natural to set on the table in front of each guest, is not of older use than the twelfth century. Even at that time every plate served in common for two or three persons. Before that, our ancestors ate, as I have done myself, among the rajahs of Oceania, each one taking the morsels with his hand from the common dish.

Grand commemorative medals, seals affixed to documents, inkstands, and tokens were struck in tin. The use of this metal was still more general in Europe in the fourteenth and fifteenth centuries. The tin eating-dish came into general use, even among peasants and workingmen, and was provided for animals. Queen Isabella's cats and the Emperor Frederick's hunting-birds had them; and tin drinking-dishes were made for the royal birds and for song-birds of every kind. Barbers' emblems, to the seventeenth century, representing a bearded figure, were of tin, to distinguish them from surgeons' signs, which were of yellow metal or brass.

Relegated till then to the kitchen or the offices of the large convents or the houses of the great lords, save in perilous times when it was brought out to take the place of silver plate on the masters' tables, tin passed, in the fifteenth and sixteenth centuries, into

FIG. 3.—CAMPBELL'S TIN LODE (PAHANG CORPORATION), SHOWING ANCIENT WORKINGS.

the hands of real artists. It then furnished the material for those wonderful pieces of goldsmith's work that were saved by the low price of the metal from the melting-pot which works of gold and silver could not escape, and which have come down to us as precious specimens of middle-age art. The pewterers of England, Flanders, and Spain, particularly of Barcelona, then produced works of real taste. The most remarkable art-works which remain to us from that epoch were produced in France and Germany, especially in Nuremberg, whose pots and plates of tin were as famous as its dolls. Tin thus had then all the honors of the precious metals. It still shares with the precious metals the advantage of cleanliness, which is set forth by many authors, who recommend it for the preservation of medicines that would be changed by contact with any other metal.

The importance of the question of the source whence tin was derived at such a remote age was indicated by M. Daubrey, when he said, in the French Academy of Sciences, that this metal presented a double interest: "On one side, its use in the form of bronze characterized a

grand epoch in human history; and, on the other side, the appearance of the mineral, not resembling any metallic substance, and the rarity of its deposits, supposed knowledge among the first miners of which we have hardly any other evidences. What country, then, in which tin is produced, was sufficiently civilized more than fifty centuries ago for its people to have knowledge enough of mineralogy to recognize the metal in the dark mineral that contains its oxide; and which had such a social organization as to make practicable the different operations and enterprises on which its extraction depends?" M. Germain Bapst expressed the opinion, three years before our first visit to Pérak, in one of the most remarkable and interesting works that have been published on the subject, that this country was the peninsula of Malacca.

A curious relation has been traced between the names which the Malays of the peninsula give to tin and lead—*tima pouté* (white), tin, and *tima itam* (black), lead—and the names given by Pliny—*plumbum candidum* (white lead, or tin), and *plumbum nigrum* (black lead, or lead); and also between the Malay *tima* and the English, Dutch, and Danish *tin*, the German *zinn*, and the Swedish *tenn*. Etymologists ask if this Malayan application of tin at a time when the kassterides islands, as yet without a name, were lying in the solitude of their dense forests, and the primitive populations of Switzerland, who also used tin for the ornamentation of their earthen vessels, had not yet built their lake villages, did not start from Malacca, and, carried by slow migrations, but directly, and over the heads of the Assyrians and Greeks, reach the extremity of Europe at a much later period.

Thus, this peninsula of Malacca, which is now covered by virgin forests inhabited by wild orang-sakeys, dotted with swamps that have to be crossed on elephants' backs, peopled by rhinoceroses and tigers, may at that time have been at the head of the world's civilization, and had its railroads, telegraphs, telephones, temples and theatres, artists and journalists, deputies and bankers, speculators and pickpockets—everything, in fact, that appertains to the last expression of progress, but under very different forms—perhaps even its Eiffel Tower in bamboo—while Europe was still in the period of its orang-sakeys. Such is the way of the world. Why should not every country have its turn? —*Translated for the Popular Science Monthly from the Revue Scientifique.*

A SATISFACTORY report has been made of the results of the first year's working of the new educational programme of the Central Provinces of India, in which special provision is made for technical education.

ANIMAL AND PLANT LORE.

By Mrs. FANNY D. BERGEN.

III.

A FEW of the many groundless beliefs concerning both the useful and the injurious powers of certain reptiles and batrachians have been already enumerated, but such fictions are by no means confined to these uncanny-looking tribes of animals. Indeed, it would seem as if such a knowledge of the real nature of the commonest animals and plants as might readily be acquired by even untrained observers had been altogether supplanted by chimerical delusions which are incredibly hard to eradicate, for, as Dasent remarks, "popular tradition is tough."

Among the ancient Egyptians, cats were highly revered, sacrifices even being offered them and temples built for them, and after death many were preserved as mummies. Travelers state that the modern Persians, too, greatly esteem the domestic cat. But from very early times, in most countries where the cat has been kept as a domestic animal, she seems to have been an object of suspicion. Cats have been the reputed familiars of witches; have at other times been supposed to incarnate witches, or even the father of witches, the devil himself. It is, then, natural enough that cats should figure rather prominently in the list of animals credited with exceptional powers for good and evil. Remnants of many ancient beliefs concerning such powers are still found—some among us, and more, it may be, in older countries. A trustworthy old woman whose early life was spent near Cork, Ireland, tells me that it is well known that in old times cats could sometimes speak, and that she herself remembers one instance in her girlhood of a cat speaking with a human voice. "It was on an oiland aff the coast of Oireland," said she, in her queer mixture of the brogue and Yankee dialect, "a bit o' land all surrounded with water. There was a woman was cardin' wool, and after she carded it she put it into her sieve,* and then her cat came along and pulled it about, and she quished him away, and whin she did that he said, 'Ye'd better lave this oiland, or ye'll be sorry.' And nixt day there came up a very high tide, and swipt away ivery livin' thing on the oiland. I suppose the cat just wanted an excuse for spakin' whin he tangled up the woman's wool. Ah, cats are very knowin'! and there's great virtue in a cat's blood, 'specially that of a black cat, or its skin, aither." Al-

* A kind of wide hoop, with the bottom covered with tanned sheepskin, and used to hold the carded wool.

most every one is familiar with the time-honored belief that a cat must not be left alone in the room with a little child for fear that "the cat will suck the baby's breath." So general is the belief in this breath-sucking power of the cat that I have taken pains to consult several distinguished physicians in New England as to its probability, and have received from each a most unequivocal statement of disbelief in any such phenomenon. One eminent Boston physician suggests that the notion may be based on the fact that a cat likes warmth, and naturally might lie up close to the warm breath of a sleeping child. Any injury which the latter might receive would therefore come from breathing an impure air, charged with carbonic-acid gas, and if the cat were diseased—for instance, had consumption—there would be the possibility of inhaling the bacilli or germs of tuberculosis. But is it not more than possible that the popular apprehension is descended from the old-country dread of the animal's connection with witchcraft? De Gubernatis cites the fact that, in Monferrato, black cats, being thought to be witches, are carefully kept away from the cradles of children; and the same precaution is taken, for the same reason, in Germany. In the latter country, black cats are in general thought to be ill-omened creatures, and, if one is found on a sick-bed, it foretells death; or if on a grave, it signifies that the soul of the departed is in the possession of the evil one. In earlier times, I conclude that black cats were usually considered to be especially evil-boding; but this notion has apparently undergone a change, so that now the white or light-colored cat is often reckoned the forerunner of evil, while the black one is the harbinger of good. There is a popular saying in various parts of New England that it betokens good luck to be followed by a black cat. A black or gray cat or kitten coming to a house will bring good luck, but a white one is a sign of calamity. "If you drive away a black cat that comes to you, you drive away your luck." The possession of a black-nosed, "smutty-nosed," cat brings wealth, while in Maine it is said the ownership of a white cat entails poverty. In Canada and parts of Michigan I find the notion is that lucky cats are those of three colors, and therefore the owner of one of the not uncommon variety, mottled with black, white, and orange, should keep her as a *mascot*, or luck-bringer. Among the negroes of Alabama it is believed that after death the spirits of old maids take possession of black cats. There is a popular belief in parts of Pennsylvania that, if by accident cats' hair be swallowed, it will turn into worms. In central Maine one may find a more generalized form of this superstition. The belief there is that, if any kind of a hair be allowed to enter the human stomach, it will gradually change into a snake—the species of the latter undefined. A native of Cumberland, England, has told me that there it is a common say-

ing that one must not swallow a hair of a cat, since if swallowed it will develop into a kitten within its hapless host.

From southern Illinois comes the notion that a felon may be cured by simply putting on, dry, three hairs from the tip of a black cat's tail. It would be so very easy a matter to test the efficacy of this remedy that it is almost incredible that experiment has not before now dissipated such an absurd belief even from the most credulous mind. Possibly there is some relation between this prescription and a saying found in central Maine that in the tip of every cat's tail are three hairs of the devil. All are aware of the ease with which in cold, dry weather, the fur of a cat is electrified by friction; but who would imagine that any connection could be conjectured between this phenomenon and lightning? There is, however, a New England superstition, of greater or less extent, that it is very unsafe to tolerate the presence of a cat during a thunder-storm. I know of one lady in Salem, Mass., who never allows her cat to remain in the living-rooms of the house when a thunder-storm is threatened. No sooner do dark clouds begin to gather than Tabby is relegated to the cellar for fear "she may draw the lightning." The reasonableness of this precaution is quite worthy of the superstition which occasions it. The grease tried out by roasting a perfectly black cat is recommended in northern Ohio as a curative ointment in any disease of the skin. From central Maine came the preposterous notion that consumption may be cured by cooking a black dog (one without a white hair) and eating the fat on bread. In the same region a much-prized unguent for pimples, roughened skin, or any other cutaneous disturbance, is the grease of a weasel. It would certainly seem that but a trifling quantity of fat could be obtained from one of these slender creatures. Pliny states that the gall of one kind of weasel (probably the ferret) is a most efficacious remedy for the sting of an asp; also that the flesh of another species, preserved in salt, is a cure for the bites of serpents. The dried flesh of the weasel was often kept by the ancient Romans to be given in small quantities as an antidote for any narcotic poison. Indeed, great remedial powers were, according to Pliny, attributed by his contemporaries to these animals, their ashes being often kept to form an important ingredient in some of the grewsome compounds that figured so largely in Roman therapeutics. Most Aryan mythologies abound in tales of the supernatural wisdom and cunning of the weasel. Phædrus and Æsop both introduced it into their fables; and Aristotle, in his History of Animals, among other attributes ascribes to it enough reasoning foresight to eat the herb rue before attacking serpents. The Greeks supposed the odor of this plant to be obnoxious to these reptiles, and credited their wily adversary with a

knowledge of the fact. Wherever found, the weasel has, and I suppose deservedly, a general reputation for great cunning and alertness. But of all the various beliefs in its fabulous powers and attributes so prevalent among earlier civilizations, few, so far as I have been able to ascertain, seem to have descended to our own time and country, though a good many still hold their ground in various parts of the British Isles. In the north of England it is popularly thought to be very unsafe to molest a weasel or to kill or injure its young, lest the artful animal spit on the offender and paralyze him, or else secretly spit into his food and so poison him. A young emigrant from county Sligo, Ireland, has told me that the peasants there have undoubting faith in this capacity of the weasel to avenge itself by the voluntary ejection of saliva that is poisonous to man. I wish I might reproduce the rich brogue and open-eyed credulity with which this Irish boy related several stories illustrative both of the revengeful disposition and of the reasoning ability of the weasel. But I can only give, in an approximation to his language, two instances which he assured me had come under his own observation. "A mon in our part o' the country wonst fought wi' a weasel. She was vurry mad un' she fought 'um a long time, un' at las' she spet on 'uz shins. The mon was afeard then un' let her alone, un' I meself saah wheriver the weasel 'd spet on 'um, uz shins turned black in spots." "There was a lot o' min a-wurrkin' in a field, un' wan uv 'm tuk some little young weasels out av their nist in a wall that was theer. Thin whin th' ould weasel saah what was done wi' 'um, she just wint to the can o' milk that they had for their dinner, and spet in th' can un' wint aff; un' thin the mon wint back wi' the little weasels afther he'd watched th' ould one a bit, un' he lift thim in the nist. Un' thin th' ould weasel wint as quick as iver she cud to the can o' milk un' spilt it so the min cudn't dhrink any uv it. She wudn't be afther hurtin' 'um whin they'd taken the little wans back." The country people in county Sligo believe that these agile carnivores are so very cunning that they know all that men say about them, and so it is felt to be unsafe even to speak ill of the little thieves. It is also there thought to be very lucky to carry a purse made of a weasel's skin. There is an old custom among the Irishwomen in county Kerry to go out with bread or other food in their hands, to meet hunters coming home with their ferrets, and after feeding the latter, to keep "for luck" whatever crumbs are left over.

An old-time remedy for the disease commonly known as "the shingles" (herpes zoster) still survives in the United States, ranging from Maine through Massachusetts and New York to Ohio, and perhaps even more widely. The treatment consists in the application of the skin of a freshly killed cat to the diseased surface

of the body. In Massachusetts it is believed that to be efficacious the skin must be that of a black cat. In one country town in eastern Massachusetts the same remedy is recommended for hives. A reputed cure for asthma, still extant in Boston, is to wear a muskrat-skin, the hair to come next the chest of the patient. A correspondent from central New York *knows* of inflammation of the bowels having been cured by applying the flesh side of the pelt of a freshly killed lamb. In parts of Ohio it is thought that chilblains may be quickly relieved by wrapping the feet in a "warm, bloody rabbit-skin" (hare-skin). The last-named remedy calls to mind the method of curing ruddiness of the face by anointing it overnight with hare's blood, cited in that incomparable medley of wisdom and folly, Burton's Anatomy of Melancholy. The nausea attendant on the painful disease called milk-sickness, which is so dreaded in many of the newly settled parts of the Western States, may, it is said, be allayed by drinking hot water into which has been dropped a little freshly drawn blood of a chicken. Canadian lumbermen, when fortunate enough to shoot a deer, often wrap themselves at night in its skin in order to keep off witches.

Pliny, in his Natural History, states that the bite of a serpent may be cured by immediately applying to the wound a living mouse, split asunder, or the warm flesh stripped from the bones of a cock. We find a possible survival of these ancient Roman remedies in the application of the freshly cut surface of a stunned domestic fowl to a snake-bite. The poison is supposed to be absorbed by the quickly circulating blood of the chicken and finally to kill it. If it die before most of the poison is thought to have been absorbed, another is at once to be applied. This mode of treatment is reported from Michigan, but I have reason to believe that in a more or less modified form it prevails rather generally where poisonous snakes are found. In northern Ohio they say that a living fowl cut open and applied while bleeding constitutes another cure for "shingles." In the town of Woburn, Mass., it is not snake-poisoning or shingles, but scarlet fever and diphtheria, that may be cured by applying to the chest the palpitating body of a hen that has been stunned and immediately cut open. This last remedy recalls the account of the last illness of Philip of Burgundy (Philip the Good), in Charles Reade's admirable mosaic of mediæval life, The Cloister and the Hearth. You remember that in the latter part of the fifteenth century the duke lay sick at Bruges with the disease now known as diphtheria. "Ho! this is grave. Flay me an ape incontinent and clap him to the duke's breast," says the doctor. But no ape was to be had. "Then Doctor Remedy grew impatient and bade flay a dog. 'A dog is next best to an ape, only it must be a dog all of one color.' So they

flayed a liver-colored dog and clapped it yet palpitating to their sovereign's breast; and he died."

There is a popular supposition of wide range, based upon I know not what, that it is very healthful for children to play with dogs. A weak child, it is thought, may gain strength by being with a dog, or, if diseased, the child may be cured by having the animal "take the disease"—for example, inflamed eyes or any disorder of the skin. Within a year a college graduate told me, in perfect good faith, of acquaintances, a Boston doctor and his wife, whose little girl had been greatly afflicted with some form of eczema which they all hoped would disappear, as the parents had purchased a fine dog to play with the child.

When a dog is teething, the upper incisors, according to a New England superstition, must be removed as soon as they become loose, or he may "swallow them and have fits." Perhaps even more generally received is the fancied danger of allowing a child's milk-tooth after extraction to fall into the possession of a dog or cat, lest the animal swallow it, and the child have a dog's or cat's tooth grow in place of the lost one. The Mexicans and Indians in Texas say that every animal has brains enough to tan its own skin; and so the latter, in the case of the wolf, panther, wild cat, and some other animals, is mainly prepared by rubbing into the flesh side of it the brains of its former wearer. A somewhat common fancy among children, perhaps too among adults as well, is that "every part strengthens a part"—that is, that the liver, heart, brains, and so on of animals, when eaten, go directly toward nourishing the corresponding organs in the eater. A similar doctrine was worked out in great detail by the American Indians, and is, I believe, held by many other savage tribes. It seems altogether probable that such beliefs, wherever found among civilized people, old or young, are survivals from remote antiquity, and that they are closely akin in their nature and origin to the well-known doctrine of signatures which has played so great a part in the systems of medicine of primitive peoples.

Mr. Charles Aldrich, of Webster City, Iowa, relates the following curious superstition: "A neighbor residing on a small farm near me has, on several occasions, spoken of his experience with 'hog mice.' He came to this country many years ago from Northamptonshire, England, where he had often seen these strange animals. They are also occasionally seen by him here in Iowa. This mythical rodent is about the size of a barn mouse, but its striking peculiarity as to its outward appearance is, that it has a head and face fashioned exactly like that of a hog. It is a very 'uncanny' little beast. If it merely runs across the body of a sleeping person, or of a domestic animal, such unfortunate person or animal will be grievously afflicted

with lameness or soreness wherever the mouse sets down one of its little feet. Serious disability often comes from the touch of the ''og mouse.' In some extreme cases the affliction is well-nigh incurable, and may last a lifetime. My old friend said that it was no hearsay matter with him. He had 'seen 'og mice both in Northamptonshire and 'ere in Hamerica.' One of his colts 'was disabled by a 'og mouse running hover it, and was a long, long time getting well.' A striking peculiarity of the hog-faced mouse, according to my old friend, is, that it is never seen at rest, but always 'on a dead run,' as if fleeing from pursuit."

It seems to me almost certain that this redoubtable ''og mouse' is merely a shrew, whose long and pointed snout might suggest the visage of a hog. In Great Britain the most maleficent powers are commonly attributed to shrews, and an interesting passage concerning the matter in White's Natural History and Antiquities of Selborne deserves to be quoted *verbatim:* "At the south corner of the plestor, or area, near the church, there stood, about twenty years ago, a very old, grotesque, hollow pollard ash, which for ages had been looked on with no small veneration as a shrew ash whose twigs or branches, when gently applied to the limbs of cattle, will immediately relieve the pains which a beast suffers from the running of a shrew mouse over the part affected; for it is supposed that a shrew mouse is of so baleful and deleterious a nature that, wherever it creeps over a beast, be it horse, cow, or sheep, the suffering animal is afflicted with cruel anguish, and threatened with the loss of the use of the limb. Against this accident, to which they were continually liable, our provident forefathers always kept a shrew ash at hand, which, when once medicated, would maintain its virtue forever. A shrew ash was made thus: into the body of the tree a deep hole was bored with an auger, and a poor devoted shrew mouse was thrust in alive, and plugged in, no doubt with several quaint incantations long since forgotten. As the ceremonies necessary for such a consecration are no longer understood, all succession is at an end, and no such tree is known to subsist in the manor or hundred."

It appears that similar powers for evil have also been attributed, in parts at least of Great Britain, to field mice, which by creeping over the backs of sheep were thought to produce paralysis. The remedy for such an injury was to inclose the mouse in a tree, and stroke the afflicted animal with its branches as above described. How far, if at all, these old-country superstitions have become naturalized among us I do not know.

The belief that the American porcupine (*Erethizon dorsatus*) can at will "shoot" its quills is one of wide acceptance among unscientific people. I remember the woodcut in my first spelling-book, labeled *porcupine*, and how, in reply to my questions in

regard, to the nature of the bristly-looking little fellow, I was told of his protective power of discharging a volley of quills at either a hunter or any four-footed enemy. This interesting fable about our own unaggressive rodent is doubtless an application of a similar exaggeration of earlier origin concerning the African porcupine. No doubt the story arose at the outset from the extreme readiness with which the quills are detached from the skin of their owner, contrasting remarkably as it does with the savage hold which their minute barbs take of the flesh of the incautious meddler in whom they lodge.

A cure for a felon, recommended in central Maine, is to wrap the offending finger in the thin membrane which lines an egg-shell. More interesting than this is the south of Ireland conceit that sucking the first egg laid by a black hen will clear the voice and render it musical.

One of the most unique of veterinary remedies is the following sent me from Bradford, Mass.: "If a cow lose her cud, put a live frog down her throat and it will bring back the cud."

In Alabama and Texas a hymenopterous insect, of the family *Mutillidæ*, which bears a superficial resemblance to a red ant, is locally known by the entirely undeserved name of cow-killer, from the supposed destructive effect of its sting upon cattle.

The dragon-fly is greatly feared by little folks in Maine, as they believe that it often sews together the lips of children, and if the mouth be left open to prevent the sewing of the lips the warning cry, is "Look out, he'll sew up your swallow!" A very cautious little girl, therefore, was accustomed on sight of one of these insects to open wide her mouth, keep her lips far apart, and then cram her fist into her mouth to keep the enemy out of her throat. In parts of Massachusetts the story goes that it is only children who tell lies who are in danger of having their mouths sewed up by the "devil's darning needle," while in New Hampshire and parts of Pennsylvania, the children think that their ears, eyelids, nostrils, and lips must be guarded, or they may be sewed up by the dreaded darning-needle. This graceful and beautifully colored insect has various names besides the well-known one just mentioned. In New Jersey it is often called "spindle"; in the neighborhood of New Orleans, "mosquito-hawk," and very likely this may be a most rational appellation; but it goes without saying that that of "snake-doctor," common in many of the Southern States, is entirely senseless. The negroes and ignorant whites, however, really believe that ailing snakes are attended by these flying "doctors." In Tennessee and Illinois either "snake-doctor" or "snake-feeder" is the popular name, and the latter is the one in general use both among children and adults in Ohio, Indiana, and some other States of the Mississippi basin. When a child in northern

central Ohio, I remember that neither my playmates nor myself doubted, when we saw dragon-flies darting to and fro or hovering over ponds or swamp-lands, that they were carrying food to their friends the snakes; and the sight of a snake-feeder always put those who feared snakes on their guard.

Some years ago a friend of mine was spending the night in Boston. Her hostess advised her, upon retiring, to be sure and keep the bedclothes well over her feet during the night, as the house was infested with cockroaches, and it was said that the insects would gnaw one's toe-nails if opportunity offered. This suggests a rather popular New England superstition that if you kill a cricket the rest of the tribe will come unawares and bite holes in your clothes. We find the same superstition in Ireland. The Irish in general say that it is very lucky to have crickets come to take up their abode in your premises, only you must be very careful not to injure one. A young Irishman once told me that if by chance boiling water were spilled upon one, as might easily happen among the peasants who cook by an open fire, about the hearth of which the crickets like to live, the unlucky person who had done the injury would be sure to find that the crickets had gnawed holes in his socks and other garments during his sleep; at the same time and in the same room the clothes of other persons who had not harmed the crickets would be unmolested. A Maine saying is that, if one of the sprightly elves become imprisoned in some crevice, ill-fortune will surely attend any bystander who does not release him. In some places with us the cricket is said to be propitious, but there is a Maine belief that its chirping foretells sorrow. This is a probable outgrowth of the saddening effect of long-continued listening to the little reveler's music, so mingled in its cheer and pathos. We may pretty certainly conclude that our whimsies about the cricket have in the main been directly transplanted from the British Isles, while those of the latter region are, in turn, modified versions of ancient ancestral beliefs common to many branches of the Aryan race. In White's Selborne the author says, in speaking of crickets: "They are the housewife's barometer, foretelling her when it will rain; and are prognostic sometimes, she thinks, of ill or good luck, of the death of a near relation, or of the approach of an absent lover." Among various prognostications of death recounted in the poet Gray's Pastoral Dirge we find—

"And shrilling crickets in the chimney cried."

The Spectator says that the voice of the cricket has inspired more terror than the roaring of a lion. According to Pliny, the cricket was an insect greatly esteemed by ancient magicians.

It is often said that the house-fly is indigestible by the human

stomach. If one is so unfortunate as to swallow a fly, the comforting remark very apt to be offered among country people is: "Well, it'll come up; a fly won't stay on the stomach, you know."

In central Illinois pills made by rolling up spider-webs into small balls are recommended to be taken for ague. In connection with this remedy it may be interesting to notice that Burton, in his Anatomy of Melancholy, tells how his mother, who was much given to doctoring the poor of her parish, had great confidence in the efficacy, in ague cases, of a spider inclosed in a nutshell wrapped in silk, to be worn as an amulet by the patient. Burton himself was at first incredulous, but after some observation he came to believe that the amulet was beneficial. His own conclusion was greatly strengthened upon his finding authority for this use of the spider in the writings of Dioscorides, the famous botanist, who lived in the early part of the Christian era, and whose Materia Medica, written in Greek, was for fifteen hundred years the highest medical authority. Carrying spiders upon the person as an ague-cure must once have been somewhat popular in England. Brand quotes from the diary of Elias Ashmole, April 11, 1681, the following: "I took early in the morning a good dose of elixir and hung three spiders about my neck, and they drove the ague away. Deo gratias!" Indeed, a vastly greater antiquity may be assigned to this absurd practice, for the use of a spider's web or the creature itself as a specific for ague can at least be traced back to the first century of our era; for Pliny, in prescribing for this disease, says: "It may be worth while to make trial whether the web of the spider called 'lycos' is of any use applied with the insect itself to the temples and forehead in a compress covered with resin and wax; or the insect itself, attached to the body in a reed—a form in which it is said to be highly beneficial for other fevers." In the medical chapters of his Natural History Pliny again and again speaks of the remedial virtues of spiders and their webs, and, among multifarious prescriptions of this kind, advises the application of a spider for three days as a cure for a boil, care being taken not to mention the animal's name before applying it; also of cobwebs wet with oil and vinegar for fracture of the skull, or of the web of a white spider for chapped lips. I have chanced upon several other spider-web remedies in our own country besides the ague-cure above mentioned. A Deerfield (Mass.) mode of treatment for felons is merely to wind the finger about with cobwebs. In northern New York cobwebs wet in hot water and applied externally are recommended for the relief of pain in diseases of the kidneys and bladder. The same application is used in parts of Vermont for acute inflammation of the breast.

A quaint custom is widely prevalent among country boys and

girls of asking a "daddy-long-legs" to point out the direction in which pasturing cattle may be found. When I was a little girl in northern Ohio, many a time, before starting to drive home the cows from a woods-pasture—in which they might easily have wandered out of sight—have I looked about in the angle of a gate-post, or under the cap of a board fence, in whose shady corners the daddy-long-legs often lurk, and, having found one of the torpid beings, seized him by one leg and held him as I repeated our prescribed incantation:

"Gran'-daddy, gran'-daddy-long-legs,
Tell me where my cows are, or I'll kill you!"

Naturally, the spider, discomfited by his bondage, would lift one of his legs, and the cows, it was said, would be found in the direction indicated by this uplifted leg. I don't think that we children really believed that this indication would always hold good, or that we even paid very much attention to the path so designated; but, as I remember it, we felt it to be the proper thing to do to consult our oracle, and I doubt not the ceremony sent us off on our evening quest with better courage. The same custom is reported from different parts of New York State, Indiana, Illinois, and Tennessee. The incantation varies somewhat with the locality. In Tennessee it is simply—

"Daddy-long-legs, which way are my cows?"

An old physician writes me that "in western New York, sixty years ago, the verses ran—

'Grandfather gray-beard,
Tell me where my cows are, or I'll kill you!'

After this had been repeated several times in a drawling monotone, lengthening out the syllables 'gray' and 'kill,' if the captive lifted a leg and held it suspended for a moment, he was faithfully released; otherwise, he was ruthlessly killed." Certainly there must be some occult connection between these malodorous arachnids and the cows, for in Tennessee the farmer-boys tell you that killing a grand-daddy-long-legs will make the cows go dry.

In the pine woodlands of southern Louisiana, so a New Orleans lady writes, there are found little mounds of mud, with quite a large opening in the center of each—probably crayfish-holes. Negro nurses caution the children under their charge never to touch these tiny mounds, believing that they are snake-holes, and that any meddling will lead the snake which lives there to leave his burrow at night and come and bite the offender.

In western New York, forty or fifty years ago, the panacea for dirt or other foreign substances in the eye was what the children called "crabs' eye-stones," the two calcareous, lenticular concretions found between the stomach-walls of the crayfish. In these

gastroliths is stored away for the molting season a reservoir of material to form a new shell. The children, having no knowledge of the real use of the gastroliths, believe them to be a providential arrangement for the relief of pain in man, and for generations this belief has been entertained by adults, for the gastroliths are really the commercial eye-stones that were once widely used to remove any irritating particle from the eye; but the practice is now condemned by physicians. It is scarcely possible that there is any power *sui generis* in these neat little bodies which an artificial fac-simile would not possess. Very likely this widely credited virtue of the eye-stones is a result of the varied use in medicine of the European crayfish in past ages. Powdered gastroliths were formerly used in Europe as an antacid, while Pliny cites a score of prescriptions in which the crushed animal, the bruised flesh, the juice expressed from it, macerations in various liquids, or the incinerated and pulverized shell were recommended for all sorts of purposes from antidoting poisons to allaying fevers.

Some time ago I heard a very notable New England housekeeper ask a young girl, who was assisting her by preparing a lobster for the tea-table, if she had been careful to remove the "lady." In answer to my inquiry as to what was meant by this, I was told that there is a part known as the "lady"—a small, greenish object inside the lobster, which is a perfect image of a tiny woman seated in a chair—and that this part of the animal is deadly poison, and should therefore always be carefully removed in preparing the flesh for the table. I find that, in general throughout Massachusetts, this name of "lady" is given to the stomach, which may be imagined to bear a remote resemblance to a miniature woman. Since the lobster is a notorious sea-scavenger, the contents of the stomach would probably be very undesirable for food, though why this stigma of being poisonous should need to be attached to the hard, calcareous-toothed, inedible stomach-walls it would not be easy to tell. In central New Hampshire the name "lady" is sometimes applied to the intestine—the dark tube running lengthwise of the lobster's body—and this is considered poisonous. In Cambridge, Mass., an intelligent fish-dealer, on being questioned as to the nature and position of the "lady" in the lobster, designated by that name the edible ovary popularly called the "coral." An ingenious theory has been propounded to me to explain the cause of the so-called "lady" being dangerously poisonous. The reasoning was about as follows: "You know that lobsters must be alive when they are dropped into hot water to be cooked. If you should let them die before they are cooked, they would be poison and not fit to eat, and I suppose that the poison, which before they are cooked is scattered everywhere through its whole body, all goes into the "lady" while the lobster is being boiled."

In Louisville, Ky., the children are afraid to kill the common sow-bug (*Oniscus*), which they call "mad dog," believing that the disagreeable-looking little crustacean can give one the hydrophobia. In my own mind there is a faint recollection of having heard that a poultice made from these creatures possessed great remedial powers of some kind. The genuineness of my half-obliterated reminiscence of the therapeutical value of the sow-bug lately received an unexpected confirmation from the pages of a copy of The Complete English Dispensatory, by John Quincy, printed not far from the middle of the eighteenth century. This rare old book, which had long lain among the unconsidered rubbish in the garret of an old-fashioned New Hampshire farm-house, contains a vast amount of curious medical lore. Not a few of the remedies which it describes are so alchemistically compounded as to seem to have come straight down from the later adepts in that pseudo-science. Other preparations, again, are unpleasant enough in their composition to satisfy an ancient Roman or a modern Chinese practitioner, as witness the following (by no means one of the most objectionable):

"EXPRESSIO MILLIPEDUM SIMPLEX (*A Simple Expression of Millipedes*).—Take live millipedes and white sugar ana ℥ iij, beat them well together in a marble mortar, and pour upon them lb. j of white wine, which strain out again by hard squeezing."

This formula is quoted by Quincy from Dr. Fuller's Pharmacopœia Extemporanea as a diuretic. Among other synonyms for "millipedes" as here used, Quincy gives "sows" and "onisci." I find that Pliny recommends "millipedes" (which the editor of the translation of the Natural History in Bohn's series identifies with onisci) for pains in the ear. Holland is quoted in a foot-note in the above-mentioned translation, as sanctioning the use of wood-lice (sow-bugs) for pains in the ears; and the editor also states that English school-boys swallow them alive, and that old women advise their use in consumptive cases.

Perhaps every one has noticed the club-shaped, whitish mass at the proximal end of a freshly pulled human hair. This root of the hair, together with the attached connective tissue and adipose material, is often absent, from the fact that the hair frequently breaks off near the opening of the follicle, instead of coming out entire from the interior of the latter. So it has come about that the root of the hair is in different localities mistaken for an animal parasite, called a *hair-eater*. In many places in Maine and Massachusetts, if these bulbs are noticed among combings, people will say that the scalp is infested with hair-eaters, and that the latter must be killed, or they will certainly ruin the hair.

NATURAL AND ARTIFICIAL CEMENTS.

By Prof. LA ROY F. GRIFFIN.

THE cements now in the market are of two kinds: natural, made directly from stone; and artificial, commonly called Portland cement. The manufacture of the former consists simply in burning and grinding the cement stone, a magnesian limestone containing about fifteen per cent of silica and a little silicate of alumina. The burning drives off the small amount of combined water and all the carbon dioxide from the stone, leaving the lime and magnesia as oxides, while the grinding to a powder puts it into the best possible condition for mixing with sand and gravel, and moistening to form a mortar. Artificial cement consists of about sixty-two per cent of lime mixed with silica and silicate of alumina in nearly the same proportions as those found in the cement stone, and it is free from magnesia. This seems to be the whole difference in its constitution. In use, the artificial cement sets rapidly and attains maximum hardness in a comparatively short time; the natural cement hardens rather slowly and reaches its maximum hardness only after a long period of exposure to the air.

The increasing use of cement in modern construction, either alone or more commonly as mixed with sand and gravel, demands that the qualities of the different kinds, and the means of testing, both roughly and accurately, should be generally understood. The foundations of all important structures, in situations where they can not rest directly upon solid rock, owe their strength to cement. They are usually made of concrete, cement mixed with sand or gravel, and they are often strengthened by iron beams so as to bind the whole into one continuous mass. Tunnels under rivers, sewers, cable trenches, and all the numerous subways of our large cities, are either concrete or masonry laid in cement mortar. Their strength, again, is the strength of the cement used. And even the piers of most of the large bridges are now made in part or wholly of concrete. Oftentimes, even the walls of stone and brick buildings are rendered more secure by being laid up with mortar of which cement forms a large ingredient. Used for so many purposes, the necessity of uniform quality, and proper knowledge of the quality of the cement used, become plain.

Before examining the methods of testing now employed and comparing the results, the process of hardening needs to be comprehended. Some things are not yet quite clear in it, but it is certainly in the main a chemical process. Mixed with water, the lime and magnesia of the cement unite to form a hydrate, and it

is probable that the silicates also recombine with some of the water. This is the first step, and produces the so-called setting. It is best passed through while the cement is exposed to the air, and is the reason why cement mixtures must be used as soon as moistened. But, this now complete, a more complex process is set up. The moistened cement brought in contact with the air, or exposed to water, at once begins to absorb carbon dioxide, for all ordinary air contains the gas, and most water holds it in solution. The gas unites with the lime to form a carbonate again, and this goes on until the whole of the lime is turned back to limestone. The same change occurs in the magnesia, but in this the action proceeds more slowly. With a pure lime cement this action is probably nearly complete at the end of a few months; but, with a cement containing magnesia, it will continue for many years. The strength of the cement increases so long as the change continues. So a Portland cement will develop its full strength in a few months, while our natural cements will not for years, and, so long as it continues, the structure improves.

Rough testing of cement, so as to enable a workman to get a crude and imperfect idea of its value, is easy. Enough of the pure cement should be taken to make a ball an inch in diameter and mixed with just sufficient water to make it mold readily and be rolled into a ball. Then it should be exposed to the air and left for two hours. At the end of that time it should be set; then it should be put into water and left. It should grow gradually harder, and should show no signs of cracking or crumbling, even when left for ten days. Any cement that does not endure this test is not of sufficiently good quality to make satisfactory structures; any cement that stands this properly will be generally satisfactory if properly used.

In determining how to construct a building, a series of tests is often required that shall show tensile, breaking, twisting, and crushing strength, and also adhesion of the materials used for mortar. No one of these can be dispensed with, since material that will endure one satisfactorily will often fail utterly in another, and hence prove worthless for the use desired; but for general purposes the test of cement which is the most valuable is that which determines its tensile strength. Comparative tests of this show the value of cements from different sources better than any other one test.

To make an accurate test of any lot of cement, great care is necessary in selecting and manipulating the samples. The test sample ought not to be taken from a single package, but from several in equal quantities and thoroughly mixed. The sample must also be carefully protected from air and moisture until the test is made. When used, it must be molded with just the right

amount of water to render it plastic. Too small an amount will leave some particles dry; too large an amount will gather in masses, will evaporate, leaving pores, and will give too small results. The test is now commonly made by molding a *briquette* of a form approved by engineers, as shown in Fig. 1, which is drawn of one third actual size. The mold is a clamp of metal exactly one inch in thickness and exactly one inch across at R. This makes the area of the smallest place exactly an inch. The moistened cement is carefully placed in the mold with a spatula and pressed enough to render the whole mass homogeneous. It is left in the mold until it can be removed by opening the mold, and then it is exposed to the air for exactly twenty-four hours, after which it is put into water and allowed to rest there until the test is made. The length of time depends upon the purpose of the test. In order to make certain that all the cement produced is of a uniform quality, seven days is sufficient. Such a test is made of every lot shipped by the Milwaukee Cement Company, and probably by all other reliable manufacturers. If the test is to determine the ultimate strength developed or to compare cements from different sources, then a series of tests should be made by breaking "briquettes" made at the same time but left in water for different periods. The reason is, that a quick-setting cement will develop its full strength in a short time, and if the test is made at the end of that time it might show a greater tensile strength than another one slow in setting, even when the latter would ultimately have several times its strength.

Fig. 1.

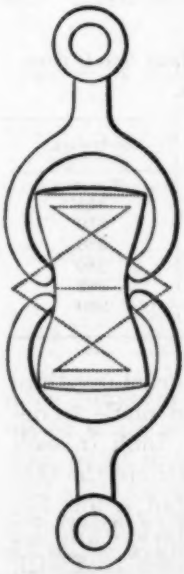
Fig. 2.

The test can be made in any form of testing machine, though one in which the test is applied by uniformly increasing the strain, as by running shot into a bucket upon the end of a lever, gives the most accurate results; but the briquette should be held in a clutch that presses accurately upon the sides, as shown in Fig. 2. This applies the tension equally, and gives a very accurate test. A long series of these were made by Mr. D. J. Whettemore, C. E., at Milwaukee in 1874, in which seventeen native cements showed an average tensile strength at the end of seven days of $80\frac{9}{16}$ pounds. The lowest of these broke at 38 pounds, while the highest sustained $139\frac{1}{2}$ pounds. Later tests made in

the same way have shown that these were unreliable as final tests of strength, because the briquettes had not hardened sufficiently, and the table would place inferior cements above those of much greater strength because the inferior develops its ultimate strength much sooner. But a comparative test of the same cements when mixed with sand in equal parts was also made, and is of very great value and probably perfectly reliable, for the tests were then made at the end of ninety days, so giving the slow-setting cements time to develop their strength.

Thus the one which in the test applied to clear cement broke at 38 pounds now sustained 152½ pounds, an increase of four hundred per cent; while the one that was the strongest at the end of seven days now broke at 204½ pounds, an increase of only fifty-four per cent. The one that showed the greatest tensile strength of all, at the end of ninety days, the Milwaukee cement, 290 pounds, broke at only 96 at the end of seven days. An experiment made with a briquette taken at random, that had been made six months and exposed to the air at least half that time, strikingly showed the same fact, for it broke only under a strain of 636 pounds. This test was made simply to show the writer the method of using the testing machine.

The United States Government had a series of tests made a few years ago, using the cements commonly sold in the West, and giving in each case the mean result of seventy-five tests. The table is so interesting that we give it entire.

Tensile Strength of Pure Cements, each Test given being the Mean Result from Seventy-five Specimens, Thirty and Sixty Days.

	Thirty days.	Sixty days.
	Pounds.	Pounds.
A Cement	320	345
B Cement	288	310
C Cement	303	330
E Cement	220	280
F Cement	202	282
D (Milwaukee)	382	350

Cement is far more often called upon to resist a crushing than a tensile strain. A large number of tests has been made to determine the weight required to crush a cube one inch in each dimension. When mixed with sand in equal proportions, the best cements will sustain a crushing weight of upward of a ton, the specimen having been allowed to harden for ninety days, while the poorest do not sustain quite half a ton, and even when mixed with three parts sand to one of the cement, the Milwaukee, which tests have shown the best, sustains over eleven hundred pounds. These tests show conclusively that structures well built of mixed cement

and sand or coarse gravel will sustain any reasonable weight without danger of yielding.

Little needs to be added upon adhesion. Many attempts have been made to determine the adhesive strength of various cements, usually without success—not because they do not hold properly, but because they hold until the brick or stone to which they have been applied is ruptured before the cement is separated from its surface. This shows that the adhesion is always sufficient for all uses, and this seems to be true of all our native cements. Their use, therefore, mixed with mortar adds greatly to the strength of the structure.

All these qualities of cement warrant its continual and increased use, particularly of all the better grades. Probably the English Portland is the best of all, but its cost is so much beyond that of our native cements as to warrant using them in its place in somewhat larger proportion in all places where time can be allowed for the hardening.

SKETCH OF THEODOR SCHWANN.

By M. LÉON FRÉDÉRICQ.

ON the 23d of January, 1878, was celebrated at the University of Liége, by the scientific men of Belgium and others representing neighboring European states and more distant countries, the fortieth anniversary of the professorship of Theodor Schwann. Men of all nations joined, by their presence or by letter, in honoring the man who, as the founder of the cell theory, had showed that all the varied and complex manifestations of Nature are one in kind, and had given a new direction to physiological research.

The object of this demonstration, THEODOR SCHWANN, was born on the 7th of December, 1810, at Neuss, near Düsseldorff, in Rhenish Prussia, and died in Liége, in January, 1882. His father and grandfather were goldsmiths; but the father, after Theodor was born, established a printing-office—himself, with the aid of an artisan, constructing the first press—which has become one of the most prosperous concerns of the kind in the Rhenish country. From it was issued the memorial volume published in 1879 in honor of Theodor Schwann.

The youth inherited from his father a decided taste for manual occupations, which afterward proved of great assistance to him in his laboratory work. While still a child he used to spend his play-hours in making miniature instruments of physics with the most primitive materials. From the primary school he went into

the humanitarian courses in the pro-gymnasium of his native village, and thence, for the completion of his studies, to the Jesuit College at Cologne. His lively intelligence and assiduity attracted the attention of all his teachers. He exhibited a marked predilection for mathematical and scientific studies, especially in physics.

He was still undecided as to the career he should choose, when he enrolled himself, in October, 1829, in the class in philosophy at Bonn. His family were deeply religious, and would have been glad to see him become a clergyman like his elder brother Peter, who died in 1881, Professor of Theology and honorary canon at Frauenburg. Therefore he began with a mixed course, including metaphysical and logical studies, along with those in mathematics and science. The latter branches in the end absorbed all his attention, and he decided to study medicine.

He became the pupil of the anatomist and physiologist Johann Müller, and that fixed his destiny. Müller, with a full appreciation of Schwann's abilities, made him an associate in his labors, and they experimented together on the motor and sensitive roots of the spinal nerves, and on the coagulation of the blood. Having passed the philosophical and scientific examinations at Bonn, Schwann went to Würzburg, where he passed three semesters, and then removed to Berlin to complete his studies and go through his final examinations. He found Müller here again, as Professor of Anatomy and Physiology, and under his direction performed the investigation on the necessity of oxygen to the development of the embryo in the hen's egg, on which was based his inaugural dissertation on receiving the degree of doctor of medicine.

Müller, insisting upon Schwann's following a scientific career, had him appointed in 1834 aid at the Anatomical Museum, of which he was director. The position was an extremely modest one, and not at all pleasant. The late Director of the Berlin Museum, Peters, speaks of having seen Schwann at work for whole days scraping the fins of a giant ray while preparing its skeleton; and many of the specimens in the zoölogical collections bear witness to the conscientious care with which he performed this monotonous work. The five years which Schwann spent here with Müller were a period of intense application, marked by a succession of discoveries. All the great works which illustrate his name date from this epoch.

A characteristic portrait of Schwann as he appeared at this time has been drawn by Henle, who passed several years under the same roof with him. He says: "He was a man of stature below the medium, with a beardless face, an almost infantine and always smiling expression, smooth, dark-brown hair, wearing a

fur-trimmed dressing-gown, living in a poorly lighted room on the second floor of a restaurant which was not even of the second class. He would pass whole days there without going out, with a few rare books around him and numerous glass vessels, retorts, vials, and tubes, simple apparatus which he made himself. Or I go in thought to the dark and fusty halls of the Anatomical Institute, where we used to work till nightfall by the side of our excellent chief, Johann Müller. We took our dinner in the evening, after the English fashion, so that we might enjoy more of the advantage of daylight. Our porter's wife furnished the meat, we the wine and wit. Those were happy days which the present generation might envy us; happy days when the first good microscopes had been sent out from the shops of Plössi at Vienna, or of Pistor and Schick at Berlin, which we paid for by exercising a student's economies; happy days, when it was still possible to make a first-class discovery by scraping an animal membrane with the nail or cutting it with the scalpel." Müller had at that time begun the publication of his great treatise on physiology, a work of scientific criticism into which he admitted nothing as true that had not been verified by himself or by his assistants under his eyes. Schwann, at his instigation, undertook a number of physiological and microscopical researches for this work. He examined the texture of the voluntary muscles; pointed out a method of isolating the primary fibers, and demonstrated the origin of the transverse striæ of their primitive bundles. He sought for the terminations of the nerves in the muscles, without being able to discover them. He did not accept the ansated termination, which was generally believed in then, but has now been disproved. He first determined the existence of the proper walls of the capillary vessels, and came very near discovering their endothelium. He demonstrated, by physiological experiments with cold water, the muscular contractibility of the arteries. He discovered in the mesentery of the frog and the tail of the tadpole the division of the primitive fiber of the nerves, an observation then without precedent. He first proved, by microscopical examination and by the re-establishment of the function, the restorableness of cut nerves; and he first made use of that faculty in approaching the question of learning whether the sensitive or motor fibers, when stimulated in their middle parts, propagate the irritation toward both the center and periphery at once, or only in one direction. He invented the muscular balance, for measuring the force of the muscle in different states of contraction. He demonstrated that muscular contractility follows the same law as the elasticity of a body which, having the same length as the muscle at its maximum contraction, is stretched out to the length of the muscle at rest. This work on muscular force

was the beginning of the series of researches by the aid of which Du Bois-Reymond, Helmholtz, and others have built up the general physiology of the nerves and muscles. It was the first instance, says Du Bois-Reymond, of the examination of an eminently vital force as if it were a physical one, and of the mathematical expression in figures of the laws of its action.

Schwann assisted, with the professors at Berlin, in the preparation of the Encyclopedic Dictionary of the Medical Sciences, to which he contributed the articles on vessels, hematose, urinary secretion, and cutaneous secretion. At this period, also, he began the experiments which led up to the discovery of the digestive ferment, pepsin; and the principles which he set forth on the subject are essentially the same as are still taught, the elucidation of a few details being all that has been added.

In one of the theses attached to his inaugural dissertation, Schwann had opposed the theory of spontaneous generation, which had begun to prevail again, after a general abandonment of Spallanzani's germ theory. The absence of microbes from preparations which had been hermetically sealed was attributed to the deprivation of oxygen. Schwann and Franz Schulze labored independently to disprove this view. Schulze showed that vegetable and animal infusions could be preserved for months in the presence of air and after renewing supplies of air, if the air was first passed over sulphuric acid to kill the germs in it. Schwann communicated to the Society of German Naturalists and Physicians the results of similar experiments, and of others in which he destroyed the germs by calcination. He explained putrefaction as a work of decomposition by the germs developing themselves at the expense of the organic substance, in proof of which he showed that arsenic and corrosive sublimate, which were poisonous to infusoria, were also the best preservatives against putrefaction. It remained to be shown that the calcination of the air did not deprive it of its essential properties of sustaining respiration and promoting alcoholic fermentation—for the advocates of spontaneous generation might say that the development of life was prevented by asphyxiation. Schwann's view was sustained when he found that frogs suffered no inconvenience in calcined air; but, when it came to apply the test to the fermentation of alcohol, no fermentation took place. Schwann was not discouraged by this, but proclaiming a new discovery, that yeast was an organic growth, and working out experiments to prove it, converted the apparently hostile result into an additional support to his theory. These ideas did not receive at once the support they deserved. They had a formidable adversary in Liebig, who set forth another theory of fermentation, and ridiculed them with a parody. Schwann, averse to controversy, made no answer to

Liebig's contradictions or to his joke. He bided his time. It came in a quarter of a century, when Schwann saw his theory extended to cover a great variety of chemical and pathological actions, and almost universally accepted; and received in 1878, from Pasteur, who had carried it to its highest triumph, a letter recognizing him as the one who had opened the road by following which his own wonderful discoveries were made.

These researches might of themselves have sufficed to make the name of Schwann illustrious. But they are relatively but little known because their fame has been dimmed in the face of the incomparable luster of his great discovery of the cell theory. The publication of the book in which the basis of this theory was laid down opened a new era in biological study. We might search in vain, says Simon, in his History of the Natural Sciences, for an example of a more radical revolution in the direction and character of scientific labors than that which was effected in 1838 and 1839 by the publication of Schwann's histogenetic theory. The revolution was sudden, and triumphed, we might say, without resistance. As Henle has remarked, the scientific soil in which this theory took root and grew had been prepared from two different points of view: one, philosophical or ideal; the other, positive or histological. The philosophical preparation dated from the beginning of the study of Nature, and was illustrated in the propensity of the human mind to look for some simple cause for the diversity of phenomena. To this we owe the monads of Epicurus and Leibnitz, Oken's philosophy of Nature, and many other efforts ancient and modern. On the other side, certain histological researches, often very modest, but coming close to the facts, had prepared a way for the cell theory. Robert Brown had discovered the cellular nucleus in 1831; Mirbel, Von Mohl, and Unger had demonstrated that the organs and tissues of plants were at bottom aggregations of cells in different degrees of transformation. Schleiden had been studying the important part played by the nucleus in the formation of vegetable cells, and had given it the name of cytoblast; and other authors had found in animals organs formed of cells. But these were as yet only isolated facts.

Schwann has himself told the story of the way the idea of his discovery first occurred to him. "One day," he says, "when I was dining with M. Schleiden, that illustrious botanist spoke of the important part which the nucleus plays in the development of plant-cells. I at once recollected that I had seen a similar organ in the cells of the dorsal cord, and instantly appreciated the extreme importance the discovery would have if I could show that it plays the same part there as the nucleus of plants in the development of vegetable cells. It must follow, in fact, in consequence of the identity of so characteristic phenomena, that the

cause which produces the cells of the dorsal cord could not be different from the one that gives origin to the vegetable cells." The two men went together to the amphitheatre of anatomy to examine the nucleuses in question, and Schleiden recognized a complete resemblance between them and the nucleuses of the cells of plants. "From that time," Schwann continues, "all my efforts were directed to finding proof of the pre-existence of the nucleus in the cell." And he goes on to tell how his views were confirmed as his researches advanced. At the time Schwann thus undertook to show that all the organs are of cellular origin, the structure of most of them was very imperfectly known. The application of the microscope to researches in animal histology was of recent introduction, and everything was to create. Schwann did not shrink from the tremendous task which opened up before him; and what he had done first for the cartilages and the dorsal cord, he tried in succession for all the other bodily tissues; and in all he had the joy of seeing his idea confirmed.

Schwann came upon many new discoveries in the course of these investigations. He first compared the egg to a cell, and recognized cells in the globules of the blastoderm; described the stellar pigmentary cells, the layers of the nail, the development of feathers, the nucleuses of the prisms of the enamel, those of the smooth and striated muscles, the fibers of the dental pulp, the cells destined to be transformed into fibers of the crystalline, etc. He called attention to the envelope of the nervous fibers which bears his name as the sheath of Schwann—all of which discoveries have been confirmed by modern research armed with its more perfect technic and superior instruments. The theory of the cell as the primordial element of all the tissues was hereafter to serve as the Ariadne's thread to the numerous investigators who devoted themselves to the study of morphology, and was to help them explain the infinite variety of organic forms. It gave a definite purpose to the application of the microscope to investigations in anatomy and physiology. It was the foundation of modern physiology, and all the morphological progress accomplished during nearly the past half-century has grown out from it. Except for its having familiarized the conception of the constitutional unity of living matter, and having declared the principle that every cell is the product of another cell, the doctrine of selection and descent could not, in the opinion of Edward Van Beneden, have gained ground. Its salutary influence in pathological anatomy and the advance of physiology was immediate and great. Acting in another direction, it put an end to the theory of a special vital force, which was in full sway when it was first promulgated, and raised up that of physico-chemical action, which has taken its place. How was it possible to reconcile the notion of cellular

individuality with the existence of a single vital force, presiding over the working of all the functions? It would be necessary to reject such a hypothesis and seek the reason of vital phenomena in the properties of molecules and atoms, or else to assign a vital force in miniature to each cell. Schwann insisted that the hypothesis was both superfluous and insufficient. He could not conceive its existence unless it possessed the attributes of intelligent beings; and preferred to seek the cause of the final purpose in nature in the Creator rather than in the creature.

Schwann was just putting in press the book containing his microscopical researches and his later results, when he was invited, in his twenty-ninth year, to take the place of Windischman as Professor of Anatomy at Louvain. His position at Berlin was pleasant, but overmodest, and offered no near prospects for promotion. So he accepted the proffer, and prepared at the end of 1838 to remove. He had to meet a considerable difficulty, in the beginning of his career at Louvain, from the necessity of speaking in French; but his lectures were successful, and still form the basis of instruction in microscopic anatomy at the university. During his term here he published a memoir on the uses of the bile, the results of which, while it gave a new operation in physiological technics, have not been fully confirmed; applied Quetelet's method of statistics to physiological phenomena; and attempted the artificial production of organic elements.

In 1848, Spring, of the University of Liége, finding the combined labors of the chairs of Physiology, General Anatomy, and Comparative Anatomy too much for a single professor to perform, asked to be relieved of a part of his burden. Schwann was selected to fill the place, and was installed in November of the same year Professor of Anatomy, Spring reserving to himself the branches of osteology and myology till 1853, when the whole course came under Schwann's charge. Some opposition was expressed at first to the coming of a stranger to the university; but this soon passed away, for the brilliant reputation of the new professor, the excellence of his teaching, and the loyalty and amenity of his disposition silenced hostile comment, and won hearts to him. In later years he refused several offers of brilliant scientific positions in Germany—from Breslau in 1852, Würzburg and Munich in 1854, and Giessen in 1855. In 1858 he exchanged the chair of Descriptive Anatomy for that of Human Physiology, and in 1870 became an emeritus professor.

Clearness, order, and method are described by those who attended his lectures as the characteristic qualities of Schwann's teaching. His courses in physiology were eminently demonstrative and experimental. Laboratory work always presented a great attraction to him. He was interested in the development of

scientific technics, and regularly made himself acquainted with new instruments and methods. He had qualities of heart corresponding with the superiority of his mind. His pupils recollect the quiet good-will and fatherly kindness which he showed toward them, and returned them with grateful demonstrations.

Although he was actively engaged in scientific pursuits during the whole of his long career, he never mingled in the discussions of the learned world after he went to Belgium. During the five years of his residence in Berlin, his discoveries followed upon one another like the explosions of a piece of fire-works; and all the great discoveries that made his name illustrious and opened new horizons to scientific thought date from that time. After removing to Belgium, he published only one work, his researches on the uses of the bile. He became almost forgotten outside of Belgium, and many, not hearing his name mentioned any more, thought he was dead. This may be charged to his aversion to personal controversy. While the cell theory, as a whole, was established, some of the details gave rise to disputes in which he did not care to engage. Believing that he had reached an ultimate principle which time would only establish more strongly, he was willing to let details take care of themselves. But he never lost his interest in the scientific movement; and, at the time of his death, he was engaged in studying the influence of electrical discharges on the development of the lower beings in organic infusions.

In Schwann's theory all the phenomena of life were explained by the properties of atoms. The cell was an aggregation of atoms obeying the laws of nature as if it were a crystal. Plants and animals were aggregations of cells, likewise machines destitute of spontaneity. But man differed from animals by possessing an immaterial element that lifted him above them and gave him freedom. It was in this way that he escaped materialism, and kept himself in line with the Church, to which he submitted his studies, having even sought and obtained ecclesiastical approval for the cell theory before he would publish it. For many years he was collecting materials for a great philosophical work in which the cell theory should take the proportions of a general theory of organisms. Beginning with the definition of the atom, his Theoria, as he called it, was to include all the manifestations of life. Psychological phenomena and the dogmas of the Catholic religion were to have definite places in it. Death prevented his beginning the final preparation of it; and his heirs could only find in his desk a manuscript of seventy-two sheets entitled Man considered from the Physiological Point of View, as he is, and as he is to be.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

CORRESPONDENCE.

PRESIDENT HILL'S DEFENSE.

Editor Popular Science Monthly:

DEAR SIR: In the April number of your magazine you say that a sentence quoted from me by Bishop Vincent in The Chautauquan "is absolutely without foundation." The objectionable sentence is, "Some counselors, like Herbert Spencer, advise us to follow our own self-interest, without concern for others, with the assurance that all will thus be happier, because more independent." The quotation is made from my volume of lectures on The Social Influence of Christianity. It is I rather than Bishop Vincent who should "either justify the above statement in regard to Mr. Spencer or withdraw it." My respect for Mr. Spencer's ability as a thinker and his sincerity as a man is so great that I should certainly withdraw a statement that I felt misrepresented him to those who may not share my high opinion of him. In seeking to render justice to Mr. Spencer, I trust you will not apply the *lex talionis* to those who may seem to you to do him wrong.

The sentence which you condemn as "absolutely without foundation" occurs after a criticism of "undiscriminating charity" in the distribution of wealth, and the citation of a case where the literal interpretation of Christ's words, "Give to him that asketh thee," led to the demoralization of a parish. In antithesis to this extreme I name Mr. Spencer as a representative of what I consider the opposite extreme—the emphasis of egoism. Of course, I do not mean that Mr. Spencer advocates an absolute and unqualified selfishness, *taking no account of the rights of others*. His teaching is, that there is a "permanent supremacy of egoism over altruism"; that "each creature shall take the benefits and the evils of his own nature, be they derived from ancestry or those due to self-produced modifications," and that "egoistic claims must take precedence of altruistic claims" (Data of Ethics, pp. 186, 187, 189). He advances two suppositions: (1) "that each citizen pursues *his own* happiness independently, not to the *detriment* of others, but *without active concern for others*"; and (2) "that each, instead of making his own happiness the object of pursuit, makes *the happiness of others* the object of pursuit"; and argues that the amount of happiness would not be greater in the second case (Data of Ethics, p. 227). He sees "inconsistency" in the doctrine expressed in the Christian maxim—"Love your neighbor as yourself" (Data of Ethics, p. 228). His conclusion is that "general happiness is to be achieved *mainly* through the adequate pursuit of *their own* happinesses by individuals; while, reciprocally, the happinesses of individuals are to be achieved in part by their pursuit of the general happiness" (Data of Ethics, p. 238). Is not the center of concern here for each one *his own* happiness, with only *so much* regard for the happiness of others *as is likely to reflect happiness upon himself?*

Mr. Spencer also says: "The poverty of the incapable, the distresses that come upon the imprudent, the starvation of the idle, and those shoulderings aside of the weak by the strong, which leave so many 'in shallows and in miseries,' are the decrees of a large, far-seeing benevolence. It seems hard that an unskillfulness which with all his efforts he can not overcome should entail hunger upon the artisan. It seems hard that a laborer incapacitated by sickness from competing with his stronger fellows should have to bear the resulting privation. It seems hard that widows and orphans should be left to struggle for life or death. Nevertheless, when regarded not separately, but in connection with the interests of universal humanity, these harsh features are seen to be full of the highest beneficence—the same beneficence which brings to early graves the children of diseased parents, and singles out the low-spirited, the intemperate, and the debilitated as the victims of an epidemic" (Social Statics, p. 354). In the foregoing paragraph Mr. Spencer has included types of all the objects of human charity. He himself says (p. 356): "At first sight these considerations seem conclusive against *all* relief to the poor—voluntary as well as compulsory; and it is no doubt true that they imply a condemnation of whatever private charity enables the recipients to elude the necessities of our social existence." He "makes no objection" to "helping men to help themselves," "countenances it rather," but he shows no concern for those who need our charity because they *can not* help themselves.

In another book he says, "It may be doubted whether the maudlin philanthropy which, looking only at direct mitigations, persistently ignores indirect mischiefs, does not inflict a greater total of misery than the extremest selfishness inflicts" (The Study of Sociology, p. 345). But all charity inspired by personal sympathy looks mainly to "direct mitigations," and overlooks those "indirect mischiefs" which the aid of the inferior is likely to produce. The "extremest selfishness" would seem from this presentation to be better than interference with that "large, far-seeing benevolence" which Mr. Spencer sees in the operation of the law of consequences.

I am not alone in my view of Mr. Spencer's teaching upon this point. In his criticism of The Man *versus* the State, in The Popular Science Monthly, vol. xxvii, p. 170, Prof. de Laveleye says, "The law that Mr. Herbert Spencer desires to adopt is simply Darwin's law—the survival of the fittest." On page 172, after citing a passage explaining the manner in which natural selection among animals is accomplished, M. de Laveleye adds, "This is the ideal order of things which, we are told, ought to prevail in human societies." In his Rejoinder Mr. Spencer evades this by saying that his Social Statics was written in 1851, while Darwin's Origin of Species was written in 1859. This is satisfactory so far as the expression "survival of the fittest" is especially "Darwin's law," but the principle is involved in the operation of the "large, far-seeing benevolence" which kills off the weak and helpless, by whatever name it is designated. Mr. Spencer does not seem to complain of M. de Laveleye's imputation, if the latter means "the survival of the industrially superior, and those who are fittest for the requirements of social life." I understand Mr. Spencer to oppose carrying the struggles of the "tooth and claw" period into our industrial era, but that he is willing to permit the operation of the principle of natural selection with more civilized weapons.

In his Rejoinder to M. de Laveleye, Mr. Spencer, after speaking of the distribution of aid by the Government, says, "If others, in their private capacities, are prompted by affection to pity or to mitigate the evil results, by all means let them do so"; but this assumes the tone of mere sufferance when he immediately adds: "No power can equitably *prevent* them from making efforts, or giving money, to diminish the sufferings of the unfortunate and the inferior; at the same time that no power can equitably coerce them into doing so." I understand this to mean that there is no right in the state to interfere with private charity, if any one is moved to it. In another place Mr. Spencer says (p. 189), "Without wishing to restrain philanthropic action, but quite contrariwise, I have in various places argued that philanthropy will better achieve its ends by non-governmental means than by governmental means." I understand by this that Mr. Spencer has no wish to "*restrain*" philanthropy, and he believes the voluntary form better than the compulsory; but he does not claim any wish to *promote charity*, and the kind of "philanthropy" he has in mind seems to be only such as is consistent with his other doctrines. As he views it, true philanthropy is best expressed by non-interference. The greatest happiness is worked out by the law of consequences, which in reality is a "large, far-seeing benevolence." "Inevitably, then, this law in conformity with which each member of a species *takes the consequences of its own nature;* and in virtue of which the progeny of each member, participating in its nature, also takes such consequences: is one that *tends ever to raise the aggregate happiness of the species* by furthering the multiplication of the happier and *hindering that of the less happy.* All this is true of human beings as of other beings" (Data of Ethics, p. 190).

I have tried to present the grounds on which my statement regarding Mr. Spencer rests. I think he means to encourage self-reliance as the primary virtue of humanity, and that he seriously believes that what is known in the world as "charity" weakens it. The question is not now whether he is right or wrong, but whether or not this is his teaching. I am aware that my words can be so interpreted as to represent Mr. Spencer as indifferent to human beings other than himself, but that is not my meaning. He distinguishes between acting "*to the detriment of others*" and acting "*without active concern for others*" (Data of Ethics, p. 227), and I use the words "without concern for others" in his own sense. If you think the word "active" modifies the meaning in any important way, I am willing to introduce it in my sentence, if I can be assured that "concern," which is but passive and not active, has any meaning. Otherwise the expression "active concern" is a pleonasm.

Mr. Spencer's doctrine is, as I interpret it, that, if each looks out well for himself, then all will be happy, at least as soon as "adaptation" has been realized; and until it has, no amount of solicitude for others or sacrifice in their behalf can possibly realize their happiness.

Very respectfully yours,

DAVID J. HILL.

UNIVERSITY OF ROCHESTER,
ROCHESTER, N. Y., *April* 12, 1890.

THE SUSPENSION BRIDGE.

Editor Popular Science Monthly:

SIR: In reply to the letter of Mr. Gustav Lindenthal (vol. xxxvi, page 844), criticising my remarks as to the lack of stability of suspension bridges (page 478), I would like to make the following statement:

I do not consider it at all necessary that my remarks upon any of the different types of bridges should be followed by the words "as usually built," as, from the title of the article, The Evolution of the Modern Railway Bridge, I could not possibly refer to any mode of construction other than that in general use or some antiquated method.

I did refer to the suspension bridge as "usually built," and as such it is very deficient in rigidity, and in practice it has been found almost impossible to so brace it laterally and vertically as to render it in any way a desirable bridge for the passage of our modern heavy trains at a high rate of speed.

I refer simply to the suspension bridge up to its present point of evolution, both as

to length of span and method of construction, and not to the possible suspension bridge of the future.

In regard to the remainder of Mr. Lindenthal's letter: A bridge to be stable and rigid, in the engineering meaning of the words, must be so designed that under any probable form of loading no change of form can take place, either in the bridge as a whole or any of its parts, other than that due to the elasticity of the material used.

The suspension bridge, as we know it, consists of a flexible chain or cable from which the roadway is hung: given a sufficiently heavy moving load relative to the dead weight of the bridge, and the form of the curve assumed by this chain or cable will change with each change in the position of the load, and the bridge can not be called stable.

The mere fact that the inverted arch is in stable equilibrium while the upright arch is not, has absolutely no bearing upon this question, when we consider the form of the materials that are used in each case. I admit that, if the steel arches of the St. Louis Bridge were inverted and braced and counterbraced in a manner similar to that made use of at present, the bridge would be as stable, etc., as the present bridge; but certainly not if the vertical and lateral bracing were dispensed with, and simply a chain substituted for the present compression arch.

It is, however, impossible to state the relative merits of different bridge designs without taking into account the length of span; and to a great extent the question is decided by the relation that exists between the dead load, consisting of weight of the bridge, and the live load, consisting of the passing train, etc. The following may be taken as the maximum economic lengths for railway bridges of iron or steel:

Plate girders	80 feet.
Riveted lattice	150 "
Pin-connected with parallel chords or arched top chord	550 "
Cantilever	1,750 "
Suspension, over	1,750 "

When the suspension bridge reaches such a size that the weight of any probable load that may come upon it is nothing as compared to its own weight—as would be the case in the proposed suspension bridge extending from New York to Jersey City, designed by Mr. Lindenthal, with a central span of 2,850 feet—then much that has been said here in regard to the instability of suspension bridges will not apply, owing to the fact that under no circumstances would it be possible to so load a bridge of such dimensions that the load would bear even an appreciable value to its own weight.

One word more in regard to "the popular and fashionable misconception as to the merits of the cantilever bridge." Its greater deflection is due simply to the fact that it is in the form of a girder fastened at one end and strained over a pier, and does not amount to a demerit in the principle.

If I understand Mr. Lindenthal's use of the expression "all other things being equal," etc., correctly to mean vertical and lateral bracing, etc., practically everything never could be equal; and the cantilever bridge, *within the limits of span given*, is in every way superior to the suspension bridge as a modern railway bridge. Respectfully,

CHARLES DAVIS JAMESON.

IOWA CITY, *April* 8, 1890.

EDITOR'S TABLE.

DOES MR. SPENCER INCULCATE SELFISHNESS?

WE print in our present number a letter from President David J. Hill, of the Baptist University of Rochester, in which an attempt is made to justify the statement contained in his book on the Social Influence of Christianity, and reproduced, with the sanction of Bishop Vincent, in The Chautauquan, that Mr. Spencer "advises us to follow our own self-interest, without concern for others, with the assurance that all will thus be happier, because more independent." If such a statement could be justified, President Hill would doubtless be highly qualified to perform the task. He has a high respect, he tells us, for Mr. Spencer's "ability as a thinker and sincerity as a man"; and we may presume that this high opinion has not been formed without adequate study of Mr. Spencer's works—such a study as would give ample command of illustrative passages in such a discussion as the present. The question now is: Has President Hill proved his case? Has he justified the damaging remark made by him in regard to Mr. Spencer's ethical system? We venture to say that he has not done so, but, on the contrary, has signally failed in his attempt. The reason is, that the facts are against him. Whether he is fully aware how much

the facts are against him is a question we do not undertake to decide; but it seems to us hardly probable that he would even try to maintain his present position if thoroughly informed on the point at issue.

Dr. Hill tells us that, in the lecture in which the passage challenged by us occurred, he was drawing attention to the two hurtful extremes of undiscriminating charity and complete egoism, as represented by Herbert Spencer; and that it was thus that he came to say that "some counselors, like Herbert Spencer, advise us to follow our own self-interest without concern for others, with the assurance that all will be thus happier because more independent." The intention to make Mr. Spencer the representative of a more or less repulsive moral doctrine is thus avowed. What, then, is the proof that Mr. Spencer advocates any such doctrine? Dr. Hill points us to a passage in which Mr. Spencer uses *some of the words* employed to summarize his teaching. But, in the passage in question (Data of Ethics, page 227), Mr. Spencer is not giving any counsel; he is simply making two suppositions and drawing a conclusion from each. These are his words: "Suppose that each citizen pursues his own happiness independently, not to the detriment of others, but without active concern for others; then their united happiness constitutes a certain sum—a certain general happiness. Now suppose that each, instead of making his own happiness the object of pursuit, makes the happiness of others the object of pursuit; then again there results a certain sum of happiness." He goes on to show that it is impossible any general gain could result from the neglect of one's own happiness in the pursuit of that of others. What proof is there here that he would not wish us to interest ourselves in the welfare of our neighbors? The whole drift of the chapter (entitled Trial and Compromise) in which the above passage is found is to show that absolute egoism and absolute altruism alike defeat the ends in view: the absolutely egoistic man fails to make himself happy, and the absolutely altruistic man fails to make others happy; *therefore*, some compromise between the two principles is necessary. Not to go any further than this we find Mr. Spencer's position sufficiently defined. He does not stand, as Dr. Hill would have his readers believe, for "the emphasis of egoism": what he emphasizes, and that over and over again, is the necessity for a due blending of egoism and altruism.

But Dr. Hill has other proofs. He quotes Mr. Spencer as saying that there is "a permanent supremacy of egoism over altruism." True; and how does Mr. Spencer explain the words? Let us quote: "The acts by which each maintains his own life must, speaking generally, precede in imperativeness all other acts of which he is capable. . . . The acts required for continued self-preservation, including the enjoyment of benefits achieved by such acts, are the first requisites to universal welfare. Unless each duly cares for himself, his care for all others is ended by death; and if each thus dies, there remain no others to be cared for." Then follow the words which Dr. Hill relies on to help his case: "This permanent supremacy of egoism over altruism is further made manifest," etc. Now, here we have it fully explained that by "supremacy" is meant priority in time and precedence in biological importance. How is this to be twisted into an exhortation "to follow our own self-interest, without concern for others"?

Dr. Hill further asserts Mr. Spencer's teaching to be that "each creature shall take the benefits and evils of its own nature, be they those derived from ancestry or those due to self-produced modifications." This is not quite correctly put, though the error is probably not intentional on Dr. Hill's part. Mr. Spencer does not say that "each creat-

ure shall," etc., but that *there is a law in nature*, which, however it may be qualified, can not be essentially changed, *that* "*each creature shall*," etc. The distinction is not without importance; as quoted by Dr. Hill, Mr. Spencer seems to be laying down a law in the spirit of a legislator, whereas he is only announcing a law in the tone of a discoverer. Now, if Dr. Hill does not believe there is any such law as Mr. Spencer announces and formulates, let him say so; the controversy will then turn on the interpretation to be given to the history of mankind. But, again, let Mr. Spencer explain himself: "Any arrangements which in a considerable degree prevent superiority from profiting by the rewards of superiority, or shield inferiority from the evils it entails—any arrangements which tend to make it as well to be inferior as to be superior—are arrangements diametrically opposed to the progress of organization and the reaching of a higher life." Is this true or not? Again, is it true, or not true, that "general happiness is to be achieved mainly through the adequate pursuit of their own happiness by individuals; while, reciprocally, the happinesses of individuals are to be achieved in part by their pursuit of the general happiness"? We say it is true; but we do not agree with Dr. Hill, who says that "the center of concern for each one is here his own happiness, with only so much regard for the happiness of others as is likely to reflect happiness." Mr. Spencer is not discussing "the center of concern," but the best conditions for the production of general happiness; and his position can only be traversed by showing that the conditions he asserts to be the best are not the best. Unless this can be done, what is the use of talking about "the center of concern"? It will be observed by the careful reader that what Mr. Spencer postulates in the first half of the above sentence is *adequate* pursuit of one's own happiness. The word is well and happily chosen, and gives the key, we may say, to the whole thought of the writer on the point involved. The adequate pursuit of one's own happiness is one thing; the inordinate or selfish pursuit of it is quite another.

Dr. Hill quotes a passage from Social Statics, and draws from it the conclusion that Mr. Spencer "shows no concern for those who need our charity because they can not help themselves." The conclusion is not justified, in our opinion, by the text. On the contrary, the whole passage is expressive of sympathy with suffering, and there is nothing in Mr. Spencer's system to check the relief of suffering except where to do so would be to entail greater subsequent suffering. Quoting from Mr. Spencer a passage in which he says, "Without wishing to restrain philanthropic action, but quite contrariwise," etc., Dr. Hill comments on it as follows: "I understand by this that Mr. Spencer has no wish to restrain philanthropy; but he does not claim any wish to promote charity." We certainly do not so understand the words "quite contrariwise"; we think they *do* imply a desire on Mr. Spencer's part to promote any charity that will be truly philanthropic and not hurtful in its effects. "As he views it," says Dr. Hill, "true philanthropy is best expressed by non-interference." Mr. Spencer has never said anything to justify this remark; but he has said that non-interference is better than a good deal of the interference that calls itself charitable. Dr. Hill tells us in conclusion that he is aware that his words—those referred to by us last month—"can be so interpreted as to represent Mr. Spencer as indifferent to human beings other than himself; but that," he adds, "is not my meaning." If Dr. Hill was aware, when he penned the words in question, that they could be so interpreted, he should in common fairness have guarded against such a misapprehension. If, on the other hand, he has only now become aware that they are open to a wrong interpretation, he should hasten to say

that he should not have used such words.

Up to this point we have been examining what Dr. Hill offers as his proofs that Herbert Spencer advises us "to follow our own interest without concern for others"; it remains now to glance at a few of the numerous passages which show in the most positive and conclusive manner that Herbert Spencer holds no such principle as that imputed to him, but, on the contrary, earnestly desires that we should concern ourselves for one another, and that sympathy should govern in all human relations. It is very singular indeed that these passages should have missed, if they did miss, Dr. Hill's scrutiny; and more singular still, if he was cognizant of them, that he should not have considered that any of them had a bearing on the question at issue. We must devote the remainder of our space mainly to quotations. To show what he understands by moral motives, Mr. Spencer says (Data of Ethics, page 121): "The man who is moved by a moral feeling to help another in difficulty, does not picture to himself any reward here or hereafter, but pictures only the better condition he is trying to bring about. One who is morally prompted to fight against a social evil has neither material benefit nor popular applause before his mind; but only the mischiefs he seeks to remove, and the increased well-being which will follow their removal." Then take the following as indicating his ideal of social life: "A society is conceivable formed of men living perfectly inoffensive lives, scrupulously fulfilling their contracts, and efficiently rearing their offspring, who yet, yielding to one another no advantages beyond those agreed upon, fall short of that highest degree of life which the gratuitous rendering of services makes possible. . . . The limit of evolution of conduct is consequently not reached until, beyond avoidance of direct and indirect injuries to others, there are spontaneous efforts to further the welfare of others" (Data of Ethics, page 147). "Sympathy is the root of both justice and benevolence" (do., page 148).

Any one wishing to know what scope Mr. Spencer allowed to the altruistic principle would naturally turn to the chapter in his Data of Ethics entitled Altruism *versus* Egoism. Dr. Hill did not find it in the interest of his argument to make any quotations from that chapter; we must, therefore, be allowed to produce a few: "That any one should have formulated his experience by saying that the conditions to success are a hard heart and a good digestion is marvelous, considering the many proofs that success, even of a material kind, greatly depending as it does on the good offices of others, is furthered by whatever creates good-will in others. The contrast between the prosperity of those who to but moderate abilities join natures which beget friendships by their kindliness, and the adversity of those who, though possessed of superior faculties and greater acquirements, arouse dislike by their hardness or indifference, should force upon all the truth that egoistic enjoyments are aided by altruistic actions. This increase of personal benefit achieved by benefiting others is but partly achieved where a selfish motive prompts the seemingly unselfish act; it is fully achieved only when the act is really unselfish. . . . Those (services) which bring more than equivalents are those not prompted by any thoughts of equivalents. For obviously it is the spontaneous outflow of good nature, not in the larger acts of life only, but in all its details, which generates in those around the attachments prompting unstinted benevolence" (page 211). Not bad for a man who is credited in an article written by a college president, and selected by a bishop for the reading of young people whose opinions are in course of formation, with advising us "to follow our own interest without concern for others"! Not so bad this either: "If we contrast early poetry, occupied mainly

with war and gratifying the savage instincts by descriptions of bloody victories, with the poetry of modern times, in which the sanguinary forms but a small part, while a large part, dealing with the gentler affections, enlists the feelings of readers on behalf of the weak, we are shown that, with the development of a more altruistic nature, there has been opened a sphere of enjoyment inaccessible to the callous egoism of barbarous times" (page 215). We have marked many other passages for quotation, not in the Data of Ethics alone, but in other works of Mr. Spencer's as well, but our limits forbid the use of them. Enough has been produced, however, to prove to any unprejudiced reader that the accusation brought against Mr. Spencer of counseling selfishness is, as we said before, "absolutely without foundation," and does signal injustice to a man the whole of whose philosophy is so strongly inspired by a social motive. In the matter of moral science many people are today in the position in which men in general were some generations ago in relation to physical science. Just as the alchemists of a former time were bent on achieving the transmutation of metals, and the astrologists on reading in the stars the destinies of individuals and of states; and just as these precursors of the scientific workers of our time would have been greatly discouraged and would perhaps have abandoned their labors if persuaded that their methods were vain and their hopes visionary and unrealizable; so, if we may be allowed to say so, the pre-scientific or anti-scientific moralists of our own time are disposed to spurn any ethical system that is not transcendental in its character and does not nourish boundless hopes. Truth, however, is making its way in the world; and gradually all intelligent men will be led to see that better, wider, and more permanent results can be achieved by working on the moral lines laid down by science, than by striving, with the older philosophies and theologies, to scale the heaven of an unattainable virtue. Let us hope that the present discussion may have a little influence in this direction.

LITERARY NOTICES.

JOURNAL OF RESEARCHES INTO THE NATURAL HISTORY AND GEOLOGY OF THE COUNTRIES VISITED DURING THE VOYAGE ROUND THE WORLD OF H. M. S. BEAGLE, UNDER THE COMMAND OF CAPTAIN FITZ ROY, R. N. By CHARLES DARWIN. A new edition, with Illustrations. New York: D. Appleton & Co. Pp. 551, with Maps. Price, $5.

THERE are only a few books that have the qualities of an originality and freshness that never wear out. Darwin's Naturalist's Voyage must be conceded a prominent place in the list. It has been a little more than fifty years since it was first published. That is a very long time in the life of a book of science and even of a book of travels. Either is likely to become antiquated and obsolete in that period. The book of science comes to be read largely as a curiosity, and to derive its chief interest as being a landmark from which the advance accomplished may be measured. The book of travels becomes a kind of history, and is valued for the illustrations it furnishes of the scenes and conditions that once prevailed. Mr. Darwin's Journal, in whichever aspect we regard it, seems as life-like, real, and sagacious as if it were the fresh record of the latest observer. The prediction made by the Quarterly Review on its first appearance, that "it must always occupy a distinguished place in the history of scientific investigation," is more than fulfilled. The work accomplished by Darwin on this voyage has been gone over, in its various parts, many times, with all the advantages of increased knowledge and approved appliances and methods of investigation; and it is surprising how little of it has to be rewritten. So far from any of its science seeming obsolete, we find all through the narrative observations which are in effect unconscious predictions, the product of the author's peculiar way of looking at things, of what has since been determined; and we are also constantly reminded that the later determinations are to

the largest extent the outcome of Mr. Darwin's own subsequent work. The track of the voyage and its principal features are well known to all persons who are conversant with the scientific literature of the last half-century, for hardly any book has been more frequently referred to in that literature. The places visited were not as familiar then as they have since been made, and of the natural life of many of them hardly anything was known. So Mr. Darwin enjoyed the advantage of being one of the first visitors and often the first scientific observer. Much of the book is, therefore, the original record by a discoverer of his discovery. Of the manner in which that record has been composed, we need say no more than quote Mr. John Murray's remark in the Prefatory Notice to the present edition, that "the extraordinary minuteness and accuracy of Mr. Darwin's observations, combined with the charm and simplicity of his descriptions, have insured the popularity of this book with all classes of readers, and that popularity has even increased in recent years." Not only are Mr. Darwin's observations as a rule accurate and anticipatory of much that has since been established; they also comprehend nearly everything that should fall under the ken of a thorough-going investigator. Seeing all that the experienced traveler sees and a great deal more than most of this class think of looking for, he portrays the scenery with a few well-defined traces; studies the geology; looks after the animal and vegetable life, with an eye that discerns as much in a few hours of sojourn at a place as duller observers might hardly discover after months of study; peers with equal keenness into the habits and most trifling actions of the animate world; takes note of the human life, of society, of manners and customs, the conditions of civilization, and of the prospects for the future of the countries he visits; and interweaves the whole with pertinent yet undogmatic speculations as to the meaning of the various features that came under his eye such as mark all the man's work—most of which have been verified, or are in course of verification by investigations to which he gave the start and on lines of research which he himself marked out. Perhaps the point to which the present interest is attached is embodied in his observations on coral reefs, which have come under discussion again in consequence of the new results obtained by the Challenger Expedition. Some of his observations—in cases where the aspect is affected by the progress of human settlement—are in more or less striking contrast with what is to be seen now. One of the strongest contrasts, perhaps, is offered in the picture of New Zealand, where the natives at the time of his visit lacked the charming simplicity of the Tahitians, and the greater part of the English were "the very refuse of society." But in the more detailed fillings of even this picture we find foreshadowings of the higher civilization that has overtaken the Maoris, and the prosperity that has attended the English colony. The present edition of Mr. Darwin's narrative is illustrated by views not in the previous editions, most of which were made on the spot by Mr. R. T. Pritchett with the book by his side, and others are taken from engravings which Mr. Darwin himself had selected for their interest as illustrating his voyage.

NORTH AMERICAN GEOLOGY AND PALEONTOLOGY. For the Use of Amateurs, Students, and Scientists. By S. A. MILLER. Cincinnati. Pp. 664.

THIS work includes a summary of the general principles of geology, with definitions of the principal formations represented in North America, and a manual of Palæozoic paleontology. The first chapter, on the "Definitions and Laws of Geology," concisely presents the principles of geological theory, including the agencies by which the structure and appearance of the superficial crust of the earth are affected; explanations of the more general terms used in geology, and remarks on the principles of nomenclature. For the systems, the generally accepted names are used. In choosing between the methods that have been followed in naming the groups, a preference is expressed for calling each group after the place in which the strata were first studied and described, because a name thus formed is sufficiently technical; it can not be used for any other purpose; and it indicates the typical locality of the exposure. On the other hand, names founded on the mineralogical

or other special character of the exposure may prove inapplicable to the representative of the same group in some other situation. The systems, as they are known in North America, are then described in their order, beginning with the Laurentian, in the first ninety pages; and the typical localities and general extent of each are noticed. The rest of the volume is occupied with the paleontological manual; and this is introduced with an ample exposition of the rules of nomenclature. The list is classified, beginning with the plants, and passing through the animal orders to the batrachians, each sub-kingdom and class being introduced by a text describing its characteristics and its orders. The names of all the species, arranged in alphabetical order, are given under the genera to which they belong, with the authors of them, the dates of publication, and, frequently, references to two places of publication. The cases are marked when generic and specific names are not known to occur in the Palæozoic rocks of North America; of synonyms, names not described as required by the rules of nomenclature, preoccupied names, and names condemned for any other reason; and erroneous references of species to genera are pointed out and corrected. A large proportion of the genera are illustrated by engravings of typical species.

FORT ANCIENT. THE GREAT PREHISTORIC EARTHWORK OF WARREN COUNTY, OHIO. Compiled from a Careful Survey, etc., by WARREN K. MOOREHEAD. Cincinnati: Robert Clarke & Co. Pp. 129, with Plates and Map.

FORT ANCIENT is a very extensive and important "mound-builders'" earthwork, overlooking the Little Miami River and its railroad, a few miles above Cincinnati. It is described by the author as "the greatest of all prehistoric earthworks in the Mississippi basin." Mr. Moorehead conceived that a full account of so remarkable a structure was desirable, and prepared himself conscientiously to furnish it. The first step was to make a survey, and for this, with a corps of competent workers, he went over the entire structure many times, and carried on a work which, he trusts, will need no additional researches to complete. In this he was assisted by Mr. Gerard Fowke and Mr. Clinton Cowen. The main purposes of the writer have been to set before the public, in as brief and exact a manner as possible, the prominent features and wonders of the monument, and to insist upon its purchase and preservation by some historical or scientific association. The fort is situated upon a plateau standing close to the river-bank, at a height of 269 feet above low water, and about 900 feet above the level of the sea. The irregular contour of the work is 18,712 feet in length, but a diameter drawn from north to south is only 4,993 feet long. The structure consists of two large inclosures, called the old and new forts, connected by a narrower passage-way which the author calls the isthmus. At the southern end of the isthmus, where it is narrowest, is the "great gateway," guarded by a mound on either side. Opposite it, at about one third of the length of the isthmus, is the "Crescent Gateway." The space between these gateways is called the "Middle Fort," and appears to have been the strongest part of the work. Numerous graves, skeletons, and remains of human work were found in and around the fortifications, and evidences of an ancient village site in the valley. The whole proves to the mind of the author that Fort Ancient was built for defense; that it was a rallying-point for a large population inhabiting a district of considerable extent, and was often the scene or the witness of fierce battles. It may have been used as a fortified village site, with people living within its walls all the time—not enough to command the inclosure, but enough to keep it in good repair. A high opinion is expressed of the ability of the constructors. They showed extraordinary patience, and "have left evidence of the possession of qualities seldom found among savages. They engineered the position of the walls with reference to the most secure places with admirable skill." With no tools, such as we use, and wicker baskets and skins as the only means of conveyance, by mere strength of hand and back, they accomplished a work before which we, even with our modern implements, would hesitate. The selection of the site, "the best for the purpose which the valley of the Ohio offers"; the skill with which the walls were carried around the entire inclosure; the care with which weak and exposed points have been

strengthened; the lookout mounds; their skulls, etc., indicate for them a higher place in the scale of being than the majority of the tribes and remnants of tribes whom the white settlers of western Ohio found there. Mr. Moorehead believes they were Mandans.

FIFTH ANNUAL REPORT OF THE BUREAU OF ETHNOLOGY, 1883–'84. By J. W. POWELL, Director. Washington. Pp. liii + 564.

THIS handsome volume gives ample evidence as to the active prosecution of the work of the Bureau of Ethnology during the year that it covers. The director reports that the field-work of 1883–'84 embraced explorations of mounds in several States east of the Rocky Mountains; explorations of ruins in Arizona and New Mexico; further researches among the Zuñi, by Mr. Cushing; and studies of signs, languages, and myths in various localities. At the same time office-work in preparing for publication materials already gathered was being vigorously carried on. The first of the papers accompanying the director's report is on Burial Mounds of the Northern Sections of the United States, by Prof. Cyrus Thomas, and was noticed in this magazine in March of last year. There is a paper by Mr. Charles C. Royce, on the Cherokee Nation of Indians, being a narrative of their official relations with the colonial and Federal governments. This record gives attention in orderly sequence to the historical traditions of the Cherokees, to their early contacts with explorers and colonists, to successive treaties and cessions of territory, with the events leading thereto, and the ensuing results. Through the paper appear biographical notices, accounts of the trials and struggles due to deportation and conflict, and many interesting facts showing the persistent advance of this intelligent people in civilization, numbers, and prosperity. The paper is accompanied by two large folded maps showing the former and present boundaries of the territory occupied by the Cherokees, also by a map of the year 1597, being the earliest which shows their location. The Mountain Chant, a Navajo ceremony, is described by Dr. Washington Matthews. The essay is divided into a translation of the myth on which the ceremony is based, an account of the nine days' exercises, and the originals and translations of the songs and prayers used in the course of the ceremonial. Four colored plates representing pictures made on the ground with colored powders, and many cuts showing implements and actions employed during the course of the rites, illustrate the paper. An account of the arts and customs of the Seminole Indians of Florida, with illustrations, is contributed to the volume by the Rev. Clay MacCauley. Mrs. Tilly E. Stevenson describes The Religious Life of the Zuñi Child, which includes a ceremony, performed before the child is four years old, by which he is supposed to receive the sacred breath of supernatural beings. The colored masks worn by the boys, and the colored figures made on the ground in this ceremony, are represented on lithographic plates.

HISTORY OF EGYPT. By F. C. H. WENDEL. New York: D. Appleton & Co. (History Primers.) Pp. 159. Price, 45 cents.

THE author's purpose in preparing this little book has been to give a brief account of Egyptian history which would be as reliable as the present state of Egyptological science presents, and to create a deeper interest in the study of ancient Egypt. He rightly believes that this study is of the greatest value, and of an importance that is growing more manifest every day to the student of almost every branch; for in it probably lie, at least in a large part, the foundations of our science and art. The story is told in a careful, scholarly manner; bears the marks of a thorough study and preparation; and is brought up as nearly to the latest discovery as is practicable in a book which requires time to pass through the press. For sources of information the Egyptian monuments are almost wholly relied upon —thus securing the correctness that is derived from contemporary records. The vexed question of chronology is ingeniously solved, or rather cut, by adopting Eduard Meyer's plan of "approximate dates," or of giving the latest date that can be assigned to the era, and leaving it understood that it is impossible to determine how much earlier the event may have taken place. This date, for the accession of Menes, is about 3200 B. C. The book supplies a real want of a compact,

popular history of this most ancient of nations, in the light of the latest researches. While we accept as valid the author's reason for not including the science, art, and literature, as well as the dynastic history—that the space contemplated by the plan did not admit of it—we hope that some one will do as good work for those features, and the popular life, too, of Egypt, as is done in this work for its politics and foreign relations. The material for illustrating them is abundant, and is lively, characteristic, human, and vastly fuller of interest than the long list of unpronounceable names of unknown kings, with their ascriptions of divine qualities to themselves, of which a chronicle of events must largely consist.

HISTORY AND PATHOLOGY OF VACCINATION. By EDGAR M. CROOKSHANK, M. B. Philadelphia: P. Blakiston, Son & Co. 2 vols.

THE story of the introduction of inoculation for the small-pox into England, and of its replacement by vaccination through the labors of Jenner, is fully told in these two fine volumes. It is a record which is extremely interesting and instructive to the lay reader, besides being historically valuable to the physician. The practitioner in England, where the work originated, will also find many of its facts and figures available for a practical purpose for which there is slight occasion in the United States, namely, for combating prejudice against vaccination. The first volume opens with a history of small-pox inoculation in various European and Asiatic countries and in England. Then follow the traditions, current among the dairy-maids in the last century, that persons who had taken the cow-pox from the animals were proof against the small-pox; and evidence is given to show that Benjamin Jesty, a farmer, purposely transferred the disease from a cow to his wife and his two children in 1774, thus anticipating Dr. Jenner in vaccination by over twenty years. A portrait of Jesty forms the frontispiece of the volume, and a small portrait of his wife is also given. An account of Jenner's life and his work in this field forms a large part of the volume, and contains extracts from many of his letters and essays on the subject. Successive chapters deal with various sources of vaccine lymph—namely, human small-pox, cattle-plague, sheep small-pox, goat-pox, cow-pox, and "grease" in horses. A brief account of the progress of vaccination in England after the death of Jenner is also given. The volume is illustrated with many full-page colored plates. The second volume consists of reprints of selected essays, beginning with the first edition of Jenner's Inquiry into the Causes and Effects of the *Variolæ Vaccinæ*, published in 1798. It contains also essays by Pearson, Woodville, Loy, Bousquet, Ceely, and other physicians prominent in the early history of vaccination, and several others by Jenner. The author contributes to this volume a paper describing an Outbreak of Cow-pox near Cricklade (Wiltshire) in 1887.

THE PSYCHOLOGY OF ATTENTION. By TH. RIBOT. Authorized Translation. Chicago: The Open Court Publishing Company. Pp. 121. Price, 75 cents.

THIS treatise is a clear and interesting study of the mechanism of the mental attitude that is necessary to any advance in skill or knowledge. It is founded upon the experiments and investigations of recent years, which have examined and defined the bodily manifestations accompanying the intellectual state. Heretofore many psychologists have been content to view attention from the subjective side only, and consequently have not given any comprehensible account of its genesis. M. Ribot uses the reverse method. He finds that there are two forms of attention: the primitive or natural, which he names spontaneous, exhibited by animals with only a few developed senses, and by man until training or force steps in; second, the artificial or voluntary, a cultivated product whose effects psychologists have dissected. Both forms are dependent upon emotional states, and the mechanism of each is motory, mainly in the form of inhibition or "arrested motion." The physical manifestations, the vaso-motor phenomena, the respiratory changes, the bodily expressions, and the cerebral effects, are the wheel-work of attention; and the patient investigation of these by Darwin, Riccardi, Galton, Maudsley, Preyer, and Féré, has made an explanation of its mechanism possible.

In considering the cerebral phenomena the old problem is encountered—whether

mind acts first upon body, or body upon mind. This M. Ribot declines to discuss. Voluntary attention originated after the earliest period of savagery, when man realized the alternative of perishing or going to work. It differs from the spontaneous form in that the motive or influence producing the emotional state is supplied from without. Educators make use of fear, sympathy, and curiosity, to cultivate attention in the child; as it advances in growth, duty, emulation, and ambition are introduced; and, finally, voluntary attention is maintained by habit and organization. A study of the internal mechanism shows that attention is accomplished by inhibition. In the normal state of consciousness, sensations, images, ideas come and go. Attention arrests this process and inhibits all but the chosen series. Energy is used to perpetuate this condition, and from this expenditure results the feeling of effort. The morbid cases of attention are treated under the heads Hypertrophy of Attention, Atrophy of Attention, and Congenital Infirmity. They prove that attention depends upon emotional excitation. Incidentally, M. Ribot gives some suggestive examples of what may depend upon full recognition of the physical nature of attention.

THE EXTERMINATION OF THE AMERICAN BISON. By WILLIAM T. HORNADAY. Washington: Government Printing-Office (Smithsonian Institution). Pp. 548, with Plates and Maps.

MR. HORNADAY is a naturalist and taxidermist by profession, and is superintendent of the National Zoölogical Park, thus combining qualifications which well fit him for making a book of this kind. He is, furthermore, a writer who knows how to interest the reader, and has composed an attractive as well as an instructive book. His purpose is to help the public fully to realize the folly of allowing all our most valuable and interesting American mammals to be wantonly destroyed, as the buffalo has been. The wild buffalo is practically gone forever; and it is doubtful whether the institution of preserves and the formation of herds, however intelligently they may be executed, will avail to save the species permanently, even in a captive state. In the first part of his work the author considers "the life-history of the bison," under the headings of Discovery of the Species, Geographical Distribution, Abundance, Character, Habits, Food, Mental Capacity and Disposition, Value to Mankind, and Economic Value to Western Cattle-Growers. The story of extermination is related in the second part. One of the most important chapters in the first part is that in which the value of the bison is estimated under domestication, in hybrids, and as a beast of burden. At present (May 1, 1889), "although the existence of a few widely scattered individuals enables us to say that the bison is not yet absolutely extinct in a wild state, there is no reason to hope that a single wild and unprotected individual will remain alive ten years hence. The nearer the species approaches to complete extermination, the more eagerly are the wretched fugitives pursued to the death wherever found." While the herds, which once ranged over nearly the whole of our country, formerly numbered hundreds of thousands of individuals, the few groups that are left count only dozens. An estimate made on the 1st of January, 1889, gave the whole number running wild—in all North America—as 635; and including those in captivity and those under Government protection in Yellowstone Park, the whole number of individuals of the species as 1,091; and these few are still hunted, and shot when found.

HANDBOOK OF PRACTICAL BOTANY. By E. STRASBURGER. Edited from the German by W. HILLHOUSE. Second edition, revised and enlarged. New York: Macmillan & Co. Pp. 425. Price, $2.50.

THIS volume embodies a course of laboratory work laid out by a botanist whom the English editor calls "one of the greatest living masters of microscopical observation." The introduction tells how to use the microscope, and describes the instruments of different makers. The first subject for study is the structure of starch of different kinds. A list of the material wanted is given at the head of the chapter; the appearance which each kind of starch should present under the microscope is described, its behavior under various reagents is noted, and directions for drawing the grains are given. The following lessons are similar in character. Among the subjects for investigation are movements of protoplasm, epidermis and stomata, the

structure of different kinds of stem, of cork, of the growing tip of stem and of root, the vegetative structure and the modes of reproduction of cryptogamous plants, and the structure of various seeds and fruits. The text is illustrated with 149 cuts. An appendix contains lists of plants and of reagents used in study, etc.

HANDBOOK OF COMMERCIAL GEOGRAPHY. By GEORGE G. CHISHOLM, Fellow of the Royal Geographical and Statistical Societies. London and New York: Longmans, Green & Co. Pp. 515. Price, $5.

COMMERCE has undergone a change of character in recent times the nature of which is indicated by the disappearance of the word "venture" from the commercial vocabulary. Cargoes of goods are not now shipped to distant ports in blind ignorance of whether or not a sufficient demand exists at their destination for the commodities sent. The legend of the rash Yankee, who apparently tempted the financial fates by sending a lot of warming-pans to the West Indies, would be impossible at this day. Commerce has settled down to a more even course, it is carried on by more exact methods, and is directed more by knowledge and less by chance than at earlier times. But there remains much room for improvement in the knowledge which importers and exporters possess of the products and the needs of foreign countries. To supply information of this sort, and in such a form that it may have "intellectual interest," is the aim of the present volume. "In writing the work," says the author, "I have had three classes chiefly in view: first, teachers who may wish to impart additional zest to their lessons in geography from the point of view of commerce; secondly, pupils in the higher schools and colleges that are now devoting increased attention to commercial education; and, thirdly, those entering on commercial life, who take a sufficiently intelligent interest in their business to make their private studies bear on their daily pursuits." An introductory chapter embodies certain general facts relating to the production, distribution, and exchange of commodities, such as differences in soil and climate, in the price and efficiency of labor, in facilities for transportation and communication, in import and export regulations, in language and money. The world's articles of commerce are then taken up, under a number of classes, and the source of supply of each, and, in case of the more important commodities, other details, such as mode of production, history of the industry, uses of the article, quality of the product from different places, and statistics of production. Then the countries of the world are taken up in succession, the location and geographical character of each is stated, its general commercial advantages and disadvantages are pointed out, after which the important products of the several sections and towns of the country are named, statistics being given in numerous instances. About thirty maps are interspersed through this part of the volume, showing the products, density of population, railways, etc., of different countries. An appendix of fifty pages gives tables of statistics in regard to the imports and exports of the chief countries of the world, and related information. The volume has a full index, which is far from a matter of course in English treatises.

THE BERMUDA ISLANDS. By ANGELO HEILPRIN. Philadelphia: The Author, Academy of Natural Sciences. Pp. 231. Price, $3.50.

THE material of this volume embraces geological, zoölogical, and botanical observations, and includes a few glimpses from the traveler's point of view. "My main object in visiting the islands," says the author, "was to satisfy my mind on certain points connected with the structure and physiognomy of coral reefs, to the study of which the Bermudas offer special advantages. I contemplated but little work in zoölogy, and that which was accomplished may be considered supplemental to the plan of work originally laid out." The first chapter, and to some extent the second, consist of "general impressions" of the islands and surrounding waters, and the inhabitants of both. The view herein given is less roseate but probably nearer correct than the descriptions of writers more dominated by poetic enthusiasm than by scientific accuracy. Prof. Heilprin next sketches the physical history and geology of the Bermuda Islands, and then takes up the coral-reef problem. He discusses the chief contributions that have been made to our knowledge of coral reefs, his own convictions being in favor of Dar-

win's subsidence theory. The following chapters deal with the zoölogy of the islands, consisting mainly of descriptions of the species collected. Prof. Heilprin states that "the Bermudian fauna is essentially a wind-drift and current-drift fauna, whose elements have been received in principal part from the United States and the West Indies," while certain mollusca and crustacea are of a distinctively Pacific type. An appendix, consisting of notes on the recent literature of coral reefs, is added. The volume is illustrated with seventeen full-page photo-engravings and lithographic plates.

LECTURES ON RUSSIAN LITERATURE. By IVAN PANIN. New York and London: G. P. Putnam's Sons. Pp. 220. Price, $1.50.

THE curious confession made in this volume that there is no originality in Russian literature, but that it acts as "a sieve for Western thought," or as "a wall against Asiatic barbarism," would seem to condemn it to the obscurity from which it has so lately emerged. The author believes, however, that the three virtues—intensity, moderation, and sincerity—which pre-eminently distinguish Russian poets and novelists, will not only rescue them from oblivion, but oblige Western writers finally to seek in them models of expression. He finds four phases of evolution in literature: First, the youthful period of joyous song; second, rebellion and lament; third, aggression and warfare; fourth, belief and inspiration. These are exemplified in Russia by Pushkin, the bard; Gogol, the protester; Turgenef, the warrior; and Tolstoi, the preacher. The Lectures are entertaining, and give the reader an insight into four typical Russian authors.

LESSONS IN THE STRUCTURE, LIFE, AND GROWTH OF PLANTS. By ALPHONSO WOOD. Revised and edited by OLIVER R. WILLIS. New York: A. S. Barnes & Co. Pp. 220. Price, $1.

THIS text-book was written more than twenty years ago, and is now recast and revised to adapt it to new means and methods of study, and to the advanced state of the science. In its new form it is offered as a suitable introduction and companion to any of the manuals of the flora of North America. Part I is devoted to structural, Part II to physiological, and Part III to systematic botany, but it is not prescribed that the subjects shall be taken up in this order. The volume is clearly printed and copiously illustrated, and is provided with a combined index and glossary.

A paper of nearly three hundred quarto pages on *The Geographical Distribution of Fossil Plants* has been prepared by *Lester F. Ward*, to form a part of the report of the United States Geological Survey for 1886–'87. It is a continuation of the Sketch of Paleobotany which appeared in the Fifth Annual Report, and will be followed by a paper on Problems of Paleobotany, in which the author will discuss many subjects in this field that he has not yet treated. The present paper takes the form of a narrative of the publication of discoveries of plant fossils. The division of the earth first taken up is Europe, and here the great number of small beds that have been discovered and of monographs that have been written about them precludes much more than a mention of each one. The flora of the arctic regions has been so magnificently treated by Prof. Oswald Heer that Mr. Ward has deemed it superfluous to pick up what little collateral matter has been brought out by other authors. Nearly the same statement applies to India, on account of Feistmantel's labors; and to Canada, where Dawson has done thorough work. But, in treating the United States, Mr. Ward has felt in duty bound to make the geographical review as complete as the data in his possession would permit. Here more analysis of the separate finds is made than in the case of the European countries. This section is accompanied by a map of the United States, on which the chief localities in which fossil plants of various geological ages have been found are indicated by different colored circles. Numerous foot-notes on every page give exact bibliographical information concerning the works referred to in the text. The paper has a full index.

The second number of the *Bulletin from the Laboratories of Natural History of the State University of Iowa* contains papers on the Anatomy of the Gorgonidæ, by C. C. Nutting—well illustrated; and on the Native Fishes of Iowa, by Seth E. Meek.

The *Report of the Council of the Cana-*

dian Institute depicts a year of progress during 1888–'89, and, according to the testimony of competent witnesses, shows that a wonderful amount of work was accomplished in proportion to the small sum of money which the society was able to command. Twenty-four ordinary meetings and thirty-six meetings of sections were held, at which seventy papers in all were read. The archæological report, by Mr. David Boyle, gives notices of several features of research and of the examination of a number of sites, and is accompanied by a paper on French relics from village sites of the Hurons, by Mr. A. F. Hunter, and a Bibliography of the Art and Archæology of the Dominion of Canada and Newfoundland, by Mr. A. F. Chamberlan.

The work of the *Geological and Natural History Survey of Minnesota* in 1888 was prosecuted by two parties, one of which, under Mr. Uly S. Grant, was occupied during a part of the season in making collections of rock samples in certain typical crystalline formations in typical localities, and afterward in the iron-ore beds; and the other, under Mr. Horace V. Winchell, spent the whole season on the iron-ore beds. The work added materially to the exact knowledge of the geology of the northeastern part of the State, and particularly to that of the nature and relations of the iron-ores. A general presentation of this knowledge, in a somewhat systematic manner, has been attempted in the report. The superintendent of the survey, Prof. N. H. Winchell, is about to enter on the preparation of a final report covering the northern part of the State.

Observations on Sexual Selection in Spiders of the Family Attidæ is a paper published in the "Occasional" Volume of the Natural History Society of Wisconsin, by *George W.* and *Elizabeth G. Peckham*. The investigation which it records is directed to the origin—in spiders—of color, and its relation to sexuality, concerning which two general theories are offered by Mr. Wallace: first, that natural selection modifies color in the female for purposes of protection; and, second, that color may be produced or intensified when there is a surplus of vital energy, as in male animals generally, and sometimes in the females, and more especially at the breeding season. Unusual facilities are offered for testing these theories by the Aranecides on account of the great numbers of their species and the wide differences between the several groups in habits and in amount of ornamentation. The study of several genera shows that, in the sedentary groups of spiders, while many of the species are plainly colored, there are nearly as many that present the most beautiful tints; and some of the wandering and very active groups are, for the most part, clothed in somber hues. Again, no relation is shown between the color development of the females and their nesting habits. The former observation is contradictory to the supposition of a causal relation between vital activity and color development; the latter to that of the need of a protective coloring, while nesting, by the female. A further explanation of the sexual coloring is then sought, with the conclusion that some groups of spiders have reached a condition of close harmony with their environment; this harmony being brought about through the same modifications of color, form, and habit as are seen among insects, to the attainment of the common ends of capture of prey and protection from enemies.

In *Remarks upon Extinct Mammals of the United States*, Dr. R. W. Shufeldt publishes studies illustrated, of *Tinoceros ingens*; The Ancestry of the Horse; Ancient Whales and Coryphodons; Half-Apes and Lemurs; the Saber-Toothed Tigers, and Hairy Mammoths and Sea-Cows.

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POPULAR MISCELLANY.

Evolution of the Fish-Hook.—"The Evolution of the Fishing-Hook" has been made the subject of a study by Mr. Edward Lovett, who discerns the first implement of the kind in the flint "gorges," and some of the flints, which are called "knives," of the palæolithic "finds." They were fastened, perhaps, to a line of twisted vegetable fiber, or to a thong of one of the whip-like marine algæ, by being suspended around the middle. When baited, the "hook" would stand up and down. Swallowed by the fish and jerked up, it would be brought at right angles to the line and stand across the throat of the

fish, so as to bring it along. Another form was a bow, sharpened at both ends and tied around the middle; or a disk of haliotis-shell, which is still used, in connection with a hook, as a trolling bait for jack or pike. Some very early hooks appear to have been provided with some kind of a barb. Of the bone hooks of the Eskimos, one is mentioned that was carved to resemble a fish; another had an iron nail for a point; and another example had the shaft of bone, the point of iron, and a polished stone sinker, showing a combination of the Stone, Bone, and Iron ages in one specimen. The Fijians use a barbless hook of mother-of-pearl for trailing over the stern of a canoe, the glitter of which attracts the fish. Some hooks from the Ellis Islands are made of the iron wire in which European packing-cases are bound, which is bent into a curve, the end sharpened to a point, and turned inward and downward, and is lashed in such a way that the strain on the hook has a tendency to keep the curve in proper adjustment. One hook is made of a forked limb. In Europe, not many hooks are found anterior to the Iron age. Among the bronze hooks from the lake-dwellings of Switzerland is one very closely resembling the hooks of our own time. An extraordinary specimen is formed of the upper mandible of an eagle, notched down to the base. Hooks in the British Islands have undergone but little change, except in finish and quality, since the dawn of the Iron period. Looking upon the subject as a whole, we find a gradual development from the rudest form of stone, through shell, wood, bone, copper, and iron, down to the beautifully tempered fine steel salmon-hook of the present day; and we also have examples in which these stages of progression overlap one another, as shown by hooks of compound manufacture, like those of shell and bone, wood and bone, bone and iron, and even stone, bone, and iron together.

Cloud-bursts. — Many recent disastrous floods have owed their severity to a sudden down-pour of water occurring when the streams of the surrounding country were already filled by rain which had fallen previously. Such a down-pour is called a cloud-burst. As explained by Prof. Ferrel, in his book on The Winds, great quantities of rain and hail sometimes collect at a considerable height in the vortex of a tornado, being held up by the strong upward current of air. When the weight of the accumulated mass has become great enough to overcome the force of the ascending current, the rain or hail pours down at one or more points. The whole system may also become weak and break up from some other cause, when the same result follows. Thus, if a tornado heavily charged with rain, in moving over the country, strikes a mountain-side, its whirling motion is checked and the upward current weakened, when a cloud-burst results. This is why cloud-bursts occur oftenest on mountain-sides. It is not to be supposed that the accumulation of water would be evenly distributed over all parts of the ascending current, but it would collect at several points; hence, when it becomes able to force its way down, it descends not in drops, but in streams which often make great holes in the ground. On a steep mountain-side, if the stream continues for a short time only, it may give rise to a land-slide, or may wash out a great ravine, through which the water rushes down to the valley below, carrying rocks and trees along with it.

Treatment of Lightning-Shock.—A report of a curious case of lightning-shock, with recovery, has been published by Dr. J. B. Paige, of Montreal, with remarks by Drs. Frank Buller and T. Wesley Mills. The subject, a young married woman, was struck by a flash, the intensity of which was shown by its effects on metallic objects to be very great. It passed from a bird-cage, hanging near her, to her head above the left eye, thence along the ear to the central line of the thorax, along the stocking suspender to the top of the stocking, leaving marks on both legs. Thence no trace of the current was detected till the foot was reached, whence it passed, leaving large rents in the stocking and slipper, but no marks on the skin. The force of the shock was enough to throw the woman from the chair on which she was sitting, upon and across another some two or three feet distant. She was found completely unconscious, motionless, with muscles relaxed, left eye closed, right one open, face purple, pulse imperceptible, and neither heart-sounds nor respiratory murmur audi-

ble. Her clothes were loosened and artificial respiration was begun, and the first sign of life appeared about three minutes afterward. Breathing was greatly impeded, when respiration was first resumed, by accumulations of saliva, which were removed. Consciousness began to return and the muscles of the arm to regain strength in between half and three quarters of an hour. Sight was restored to the right eye, but it could not be moved. Though the subject could not speak, the paralysis passed away slowly, so that in about two weeks solid food could be swallowed. Twelve or fourteen hours after the accident, intense pain set in about the head, neck, arms, and chest, which did not pass away from the head for seven days, and occurred occasionally after that. At the end of four weeks the patient was able to return to her home. In six months complete recovery had taken place, except in the left eye. To the question whether the patient could have recovered without the assistance rendered just after the accident, Prof. Mills replies that "considering that respiration was suspended, that the circulation, even with artificial respiration, was so feeble that the temperature fell, that consciousness did not return for so long, it does not seem reasonable to believe in the possibility of spontaneous recovery. But the case does seem to teach, in the clearest way, the importance of using such means as those employed in this instance promptly and perseveringly."

Natural Guides to Land Values.—The chief of the Agricultural College at Downton, England, has given in a recently published article some of the indications by which the fertility of soils may be judged. The following colors indicate barrenness in soils: 1. Black, as being in most cases caused by an excess of vegetable matter or peat. 2. White, as indicating a thin, chalky soil, or the presence of white sand close to the surface. 3. Yellow, whether dark or light. 4. Light gray. 5. Blue. 6. A piebald or variegated color. A good soil ought to be from twelve to eighteen inches deep. Alluvial soils owe their fertility in a great measure to their depth. Tenacity does much to determine the productive power of soil. Tenacity is seen in the clearly cut furrow, and the impression left by the foot when the soil is moist. In tenacious soil the footprint is clear and sharp at the edges, and every nail-mark shows; whereas, in loamy soil the tread is indistinct and the edges of the footprint crumble away. In dry weather, a cracked surface and hard yellow clods are the marks of a stiff soil. The skillful judge of land will not rely too much upon the physical character of the soil alone. Land always covers itself with herbage of some sort, from the quality and quantity of which the best possible indication of the soil's yielding power may be obtained. Plenty of timber is a favorable augury. Who can not recall some beautiful valley where the well-grown trees seem almost to meet their branches over green meadows and patches of grain and other crops? On the other hand, inclement and thin soils carry a stunted and forlorn timbering. Turning to the sort of tree, we may mention large, spreading oaks as signs of good land. The elm is found to perfection on village greens and near to homesteads where the ground has become, or always was, rich, and in other favored situations. The mulberry and the walnut, the apple and the quince, are never found vigorous on other than good land; and the ash, the sycamore, and the chestnut are also indications of fertility. Certain other trees indicate the reverse. We see plantations of larch on barren uplands and soils difficult to put to other uses. Scotch fir, spruce, yew, and other cone-bearing trees are often found on poor land. Beeches thrive on the thinnest of limestone, and the birch will grow in the most unpromising places. Coming down to the plants, none is a more unfailing guide to fertility than chickweed. Nettles never grow on bad land, and dandelions and buttercups are not seen on poor pastures. Thistles also show a good soil. The state of growing crops and the appearance of stubbles should also be noted, although such indications may show rather the character of the farming. Certain wild grasses show barrenness, while grass-land which seems covered with dead, unkempt stuff, like badly made hay, is always barren.

Gardening Classes of the Missouri Botanical Garden.—The Trustees of the Missouri Botanical Garden, carrying on the in-

tentions of Mr. Shaw, its founder, have prepared a plan of garden scholarships, providing for the instruction of a limited number of pupils in practical horticulture. The classes are intended to consist of six pupils, who will be taught for not more than six years each. They will be regarded as apprentices in the Botanical Garden, and required to work in it under the direction of the head gardener, performing the duties of garden hands, and being advanced gradually from simpler to more responsible tasks. After the first year their working hours will be reduced to five a day, that they may devote the rest of the time to study, in which they will enjoy free the privileges of the tuition of the School of Botany at Washington University. For their services in the garden they will be paid from two hundred to three hundred dollars a year, with conveniently situated lodgings. Applicants for scholarships will be examined in the upper grammar-school branches; and, in case of an excess of them, will be subjected to competitive examination, in which other branches will be brought in. The studies will be, for the first year, in practical duties; for the second year, vegetable and flower gardening, small-fruit culture, and orchard culture; for the third year, readings in forestry, elementary botany, landscape gardening, and the rudiments of surveying and draining; for the fourth year, botany of weeds, garden vegetables, and fruits; for the fifth year, vegetable physiology, economic entomology, and fungi; for the sixth year, botany of garden and greenhouse plants, ferns, and trees in their winter condition, with the theoretical part of some branch of special gardening. Pupils will also be trained in legal forms and in keeping accounts. Two of the six scholarships are at the disposal of local horticultural societies, provided their candidates pass the examinations.

Museum of the University of Pennsylvania.—The Archæological Museum of the University of Pennsylvania, begun in December, 1889, by the purchase of a small collection of stone implements, has grown in the few months since, till it includes ten thousand objects from all the United States, Mexico, Central America, and parts of South America. It is intended to make it representative of the early civilization of the Americas, and to exhibit as far as possible the implements used by the Indians, in their warfare, agriculture, and domestic life, before the advent of Columbus. It is intended hereafter to build up the collection mainly by explorations, and to this end all parts of the country will be thoroughly searched. In addition to the American specimens, the museum contains a fine collection of flints, bronze implements, and pottery from Europe, and objects from Asia, Africa, and the South Sea islands. Preparations are making by Prof. Rothrock for the establishment in the university of a Museum of Economic Botany, to consist of all kinds of woods, vegetable fibers, grains, and drugs, arranged so as to illustrate the processes of manufacture from the raw product, and the various uses to which each material may be put. It is expected to make this department of practical use to manufacturers and wood-workers, who may be guided by its aid to the selection of suitable material, and learn where it can be got.

Coffin-Nails.—Baring-Gould has contributed to The Gentleman's Magazine an article full of curious lore on this sepulchral subject. He says that the studding of a coffin with nails—which has evidently not ceased to be common in England—is a curious survival. The nails are no longer of any use, for the lid is fastened down with screws, but even when stone coffins were used — sarcophagi—the nails were not omitted. Iron was from the first regarded with superstitious reverence. In Egypt iron was the symbol of victory over death—of the power of resurrection given to man. The Romans also had a reverence for iron, and attributed to it mysterious powers. By drawing a circle on the ground or in the air, with an iron point, thrice round a person, they believed all noxious influences were banished. An iron spike applied lightly to a wounded part would relieve its pain. Rust for curative and protective purposes might be had from old nails, from which it must be removed with moistened iron. The nail was specially used because it was a symbol of fate. On the Ides of September every year the highest in authority in Rome drove a nail into the wall of the Temple of Jupiter. That day was the

beginning of the Roman year, and the driving of the nail was thought to bring with it prosperity for the new year. Livy tells us that when the gods seemed hostile and unmoved by the distresses of the nation, the dictator broke the spell of evil by driving in a nail. Once a nail driven in had banished a plague; then a nail had healed discord. Pliny says that, if a nail be driven into the pillow on which a man suffering from epilepsy has laid his head, it will heal him. In all these notices we see iron used as destroying the power of evil, breaking the force of disaster, banishing disease, expelling death. Consequently, nails were put in urns or funereal cists to keep away from them every evil power, demons, witches, and as a pledge of final restoration. The iron horseshoe nailed to a door owes its power to break the force of witchcraft not only to its being a symbol of Odin's horse, but also to the metal of which it is composed. Shears were frequently buried with bodies down till late in the middle ages. It is said that even within the memory of man they have been buried in coffins with corpses in Swabia. Sometimes as many as five were laid in the coffin with one corpse. The idea was the same as with nails—the metal was the important matter, rather than the form it took. The steel or iron was a preservative to the corpse, a protection and an assurance of resurrection. For the same reason that nails and shears were buried with the dead, swords were laid with them, and not necessarily because they would need them in the next world. Even Charlemagne was buried with his sword. The Icelandic sagas are full of stories of cairns broken into by heroes to rob the dead of their swords. Already in historic times the significance of the sword buried with the dead was lost; and in the Saga of Olaf the Saint a ghost actually invites a Norseman to break into his tomb and relieve him of his sword and other valuables.

Habits of the Manatee.—The London Zoölogical Society has acquired a living specimen of the manatee, one of the only two kinds of "herbivorous cetaceans" now existing. Concerning the habits of these animals, Miss Agnes Crane has written, from observations of a pair several years ago in the Brighton Aquarium, that lettuce and endives, of which they could eat thirty pounds a day, formed their favorite food. The male would devour at a pinch leaves of the cabbage, turnip, and carrot. Both relished those of the dandelion and sow-thistle. Sometimes the animals would swim about and pursue the leaves floating on the water; at other times the plants were seized in their mouths, drawn down, and eaten under the water, while the hand-like fore-fins were employed in separating the leaves. The food was invariably swallowed below the surface. They are not at all at ease when out of the water, but seem oppressed by their bulk. The male was observed to make a few attempts at terrestrial progress by turning himself round and moving a few inches when the tank was empty. With jaws and tail-fin pressed closely to the ground, the body of the animal became arched, and was moved by a violent lateral effort, aided and slightly supported by the fore paddles, which were stretched out in a line with the mouth. But the effect of these very labored efforts was not commensurate with their violence; and their relation to active locomotion might be compared to the state of a man lying prone, with fettered feet and elbows tied to his side.

Odd Dishes of the Olden Time.—The cook-books of a hundred or more years ago afford reading well adapted to excite curiosity of appetite, if we may speak in that way. Their lists of pickles and flavors embraced a great many articles that we do not think now of using in that way. Jams were made of vegetables; parsnips, raspberries, etc., were made into cakes; and beets, potatoes, and oranges into biscuits. For making violet cakes the directions were to "take the finest violets you can get, pick off the leaves, beat the violets fine in a mortar with the juice of a lemon, beat and sift twice their weight of double-refined sugar, put your sugar and violets into a silver saucepan or tankard, set it over a slow fire, keep stirring it gently until all your sugar is dissolved; if you let it boil it will discolor your violets; drop them in china plates; when you take them off put them in a box, with paper between every layer." Wines were made of every fruit; of such flowers and vegetables as cowslips and parsnips;

from flowers and berries of elder; from sycamore, walnut, blackberry, and balm. To make shrub, to one gallon of milk flavored with lemons and Seville oranges were added two quarts of red wine, two gallons of rum, and one gallon of brandy. The books give directions how to spin gold and silver webs for dessert, to spin birds' nests, to make a Chinese temple or obelisk, a fish-pond with silver and gold fishes, a hen's nest with strips of lemon for straw, and eggs filled with flummery, and a hen and chickens in jelly. To make a "desert island," "take a lump of paste and form it into a rock three inches broad at the top, set in the middle of a deep china dish, and set a cast figure on it with a crown on its head and a knot of sugar-candy at its feet, etc. . . . If this dish is for a wedding supper, put two figures instead of one." There are also recipes for a "rocky island," a "floating island," with sheep and swans, "or you may put in snakes or any wild animals of the same sort," "Solomon's temple in flummery," "moonshine," and "moon and stars in jelly"—a half-moon with seven stars shining out of flummery colored with cochineal and chocolate to imitate the color of the sky. Among solid dishes the books tell how to make porcupine of a breast of veal, to surprise a shoulder of mutton or any other joint, to dress a joint to look like a hen and chickens, to bombard veal, to transmogrify pigeons, to Florentine a hare, make a Solomon Gundy, make an artificial turtle, and barbecue a pig.

Trees and Malaria.—According to Prof. Corrado Tommassi Crudelli, some of the prevalent notions respecting relations of forests and malaria are mistaken ones. The relations are not direct. Forests do not contribute to the propagation of malaria unless they are growing upon a malarious soil; and they can not make a soil malarious which would not be malarious without them. But they favor the development of malaria, when it is already there, by intercepting the solar rays, and thus checking evaporation and retaining moisture in summer. When the obstacle to the direct action of the solar rays is removed from infected land, the summer drying lessens the malarious generation, and in some favorable circumstances may even arrest it. The idea prevails in Rome that forests act as a screen to prevent malaria from crossing them by causing it to be filtered out in their foliage, and the establishment of forests at certain places is advised for that purpose. But it has been proved that the destruction of woods and forests in such situations has not led to an increase of malaria, but frequently to its mitigation by promoting better drainage and improved cultivation. The production of fevers in the *Agro Romano* and in Rome is the result of a complexity of meteorological and physiological conditions. An abundant development of malaria is verified only when the malarious soil is damp and warm. The malarious charge of the atmosphere may vary greatly according to the different proportion of the two indispensable factors of malaria—heat and moisture. If both are at their maximum, so is the malaria, especially when the sky is clear. When the malarious charge of the atmosphere has been great for many days in succession, and the bodies of the inhabitants have become more or less impregnated with the malarious germs, a fall of temperature may be very injurious, by causing an arrest of the germs within the organism and preventing their rapid elimination by the secretions. Hence it is that northern winds exercise an unfavorable influence during the fever seasons.

Soda Salts in Arizona.—The deposits of sulphate of soda of the valley of the Verde River, Arizona, have long been known and extensively quarried by the *rancheros* of the region to obtain a substitute for salt for cattle and horses. They have recently been visited by William P. Blake, who found the deposits of thenardite and allied minerals associated with it to cover several acres in extent, and reach a thickness of fifty or sixty feet or more. They appear as a series of rounded hills, with sides covered with a snow-white efflorescence and a greenish-colored and yellow clay at the bottom and top, partially covering the saline beds. The bulk of the deposits consists of thenardite, in a coarsely crystalline mass, so compact and firm that it has to be got out by drilling and blasting. The white efflorescence on the hills is composed of the hydrous sulphate of soda (*mirabilite*), which occurs in close association with the thenardite. Other asso-

ciated minerals are rock-salt in beautifully transparent masses, sparingly disseminated; the anhydrous sulphate of lime and soda (*glauberite*); and "pseudomorphs," in which the glauberite having disappeared, its place is supplied by amorphous carbonate of lime exactly filling the matrices of its crystals.

Holy Things and Toys from Torres Strait.—Prof. A. C. Haddon has fitted up in the British Museum a collection of objects from Torres Strait, which illustrates the customs and superstitions of the people of that still savage quarter. Among the objects are some forty native skulls, some of which had been strung in bunches as trophy decorations of the hut of a warrior, while others had been used for ceremonies and divination. The great eccentric masks employed in semi-religious and secular dances are represented by specimens which the collector believes to be the last of their kind. One of them, a crocodile mask, had such striking powers that the native from whom it was obtained refused to put it on for fear that death would be the consequence, because it was not the season of the year when it might be legitimately worn. Of the charms, those in stone and wood shaped like dugongs are very interesting. There are charms to protect against poisoning, love-charms, rain-making charms, charms to make the tobacco-plant grow; female figures, some in coral to keep the fire in when the housewife is absent; and taboo figures and signs of various kinds. The musical instruments include some ingenious drums, "bull-roarers," and a new kind of simple construction. Of toys there are tops of considerable weight, of which the Papuan spins several on his toes at the same time, and arrangements of string used as a sort of cat's cradle. The implements and articles of clothing and those for personal adornment are varied. An ornament worn by a betrothed girl appears to be derived from two fish-hooks placed back to back. Several specimens grimly illustrate the old savage customs. A hard-wood weapon is marked with eleven notches, to indicate as many heads which the owner has cut off. A double cassowary head-dress that belonged to a late king of the island Tud was handed over by his son to Prof. Haddon, together with the boar-tusks which he wore in his mouth on war expeditions, on the understanding that they were to go to the British Museum, where "plenty men" wanted to see them. When drawings or photographs of some of the natives were being taken they would ask, "Queen Victoria, he see picture along we fellow?"—that is, Will Queen Victoria see our picture?—to which the professor replied in the same strain, "S'pose he want, he see; I no savee. Plenty men along England want to savee about you fellow." Some of these photographs may now be seen in this collection, recording features and decorations which, in a few years, will have died out.

NOTES.

Dr. S. Weir Mitchell, of Philadelphia, recently received from a woman-patient the singular present of a cord of white-oak wood, chopped down and sawed up by her own hands. He had recommended to her an active, outdoor life in the woods for nervous invalidism. She had followed his directions, with results of which the cord of sawed wood was one of the evidences.

Dr. E. N. Sneath, lecturer on the History of Philosophy at Yale, has been inspiring the preparation of a series of small volumes of selections from the leading philosophers from Descartes down, so arranged as to present an outline of their systems. Each volume will contain a biographical sketch of the author, a statement of the historical position of the system, and a bibliography. Those so far arranged for are Descartes, by Prof. Ladd, of Yale; Spinoza, by Prof. Fullerton, of the University of Pennsylvania; Locke, by Prof. Russell, of Williams; Berkeley, by ex-President Porter, of Yale; Hume, by Dr. Sneath, of Yale; and Hegel, by Prof. Royce, of Harvard. Kant, Comte, and Spencer will certainly be added to the series, and others if encouragement is received. The publishers will be Henry Holt & Co.

The American Academy of Political and Social Science, of which Prof. Edmund J. James is president, was founded in December, 1889, for promoting the study of the political and social sciences, particularly of those which are omitted from the programmes of other societies, or which do not at present receive the attention they deserve. Among them are sociology, comparative constitutional and administrative law, philosophy of the state, and portions of the field of politics. It will attend to the publication of material that will be of use to students which does not now reach the public in any systematic way. The plan of the academy includes meetings for the presentation of papers and

communications, the establishment of a library, and the dissemination of knowledge through publications and by other means.

THE Messrs. Merriam, publishers of Webster's Dictionary, issue a circular calling attention to the misleading way in which a cheap reprint of an old edition of Webster's Unabridged Dictionary is being advertised. It is the edition of 1847, the copyright of which has expired by the lapse of forty-two years. It lacks all the words that have been added to the language since 1847, and these, especially in the department of science, have been many; it contains numerous etymologies that have been proved erroneous by the results of later research; it lacks the tables of biographical, geographical, and other information, which are appended to recent editions of Webster, and it has no illustrations in the body of the volume. The reprint is produced by some method of photogravure, giving blurred letters, very trying to the eyes, and the paper and binding are so flimsy that the book must fall to pieces with very little use. It is not the current edition of Webster's Unabridged Dictionary, as its publishers wish the public to believe—it is not even the "original" edition, as it explicitly claims to be, for that was published in 1828.

THE most interesting feature of Dr. R. W. Shufeldt's report to the American Ornithologists' Union on Progress in Avian Anatomy for the Years 1888–1889, is the announcement that a Handbook to the Muscles of Birds has been prepared by the author, and is in the press of Macmillan & Co. It is based on studies of the raven. Several monographs, mostly technical, by Dr. Shufeldt and other authors, American and foreign, are mentioned in the report. Among them is one by Mr. F. A. Lucas, on the Skeleton of the Extinct Great Auk.

A CLEAR and forcible article on The Suppression of Consumption, by G. W. Hambleton, is published in Science for April 25th. Dr. Hambleton deems the most important step in suppressing this disease to be to reduce its production. The means which he recommends for this end are almost entirely hygienic, and are based on the theory that consumption is produced by conditions that impede the respiratory functions. The chief of these are compression of the chest, and the presence of dust in the air inhaled. His statements are well fortified by cases which he has treated successfully, including his own.

THE first fossil found in the "Cheyenne sandstone" of Kansas—which is considered referable to the Trinity division of Arkansas and Texas—is described by Mr. F. W. Cragin as a part of a cycad, similar to those from the Purbeck Dirt-beds of England, but differing from them in form and in the size of the petioles. A leaf of *Platanus*, found in a stratum of very fine, soft chalk of supposed Niobrara Cretaceous age, is described by the same author as of interest, both on account of its preservation in a kind of rock in which land vegetation is rare, and because it contributes evidence that chalk is sometimes formed very near land, and if so, then presumably in water of but moderate depth.

THE increase of leprosy in British Guiana is attracting attention. It was introduced by negroes from Africa, and added to by immigrants from India in 1842 and 1858, and from China in 1861 and 1862. One Indian tribe was infected with it fifty years ago from the negro colony, but no other tribe has had it. Mr. J. D. Hilles, of Demerara, who has investigated the subject, is convinced that the disease is communicable by marriage or cohabitation, and by inoculation or contact. He has seen cases that undoubtedly arose by contagion.

THE investigations of Dr. Th. Kocher, of Berne, on goitre, while they do not clear up the question of the origin of the disease, cast a dim light upon it. Comparing the water of the parts of his canton in which goitre is common with those parts that are free from it, the author found considerable quantities of organic or organized material in it. In certain goitrous parts, particular families having access to special water-supplies free, or relatively so, from this organic material are free from goitre, although breathing the same air, living on the same soil, engaging in the same occupations, and eating the same food with their goitrous neighbors. Hence, he concludes, the organic factor is the one that determines the prevalence of goitre.

MR. JOSEPH THOMSON commends the semi-civilized region forming the central area of the Niger basin as one of the most promising fields for commerce in all tropical Africa. It is densely populated, and is divided into powerful and, for Africa, well-governed empires, in which life and property are fairly secure. The people have made some advance in civilization, and are famed for the excellence of their manufactures. Inland trade is organized, an efficient transport service exists, labor is abundant, the Niger presents an uninterrupted water-way to the very heart of the region, and the country is healthy, for Africa.

A LARGE stump of *Syringodendron alternans*, discovered some time ago standing in the coal mines of St. Etienne, France, is about ten feet high, three feet in diameter at the starting-point of the roots, and twenty inches in diameter at the top. The roots resemble the fossil *Stigmaria*. The trunk has the cicatrices and flutings of the *Sigillaria*, and the leaves seem to have been linear. In a prostrate tree (upper part) of the same species a few feet from this one, the leaf-scars were more clearly marked, but smaller.

DR. E. PAGET THURSTON believes that while it is theoretically right to omit farinaceous food in feeding infants that have to be brought up by hand, a little is needed when cow's milk is used, to retard curdling. These solids, as well as the preparations of barley, isinglass, and linseed, act mechanically by adding something to thicken the milk, and entangle the curds as they are formed. In the shape of bread-crust, Brighton biscuit, or other "infant's foods," they may be added in very small quantities, so that the milk can still be sucked through the tube of a feeding-bottle.

CASES of lead-poisoning among the Jacquard weavers in a Swiss factory were traced by F. Schüler to the dust from leaden weights which are used by the weavers to carry the thread of their warp. After the varnish has been rubbed off from the weights, the lead begins to wear away, and falls in fine particles among the dust on the floor. In some cases this dust is as much as 56·86 per cent lead, and even when the utmost care was taken, nine or ten per cent of lead was found in it.

ACCORDING to Mr. Hansen-Blansted, the beech is overcoming all other trees in the struggle for existence in the Danish forests. It is driving out the birch, except in marshy places; it is taking the place of the firs; and there are signs that it is gradually gaining the advantage over the oaks.

OBITUARY NOTES.

SIR ROBERT KANE, a distinguished Irish chemist and author, died in Dublin, February 16th. He was born in Dublin in September, 1810. His father was the proprietor of sulphuric-acid and alkali works near the city, and he developed a taste for chemical knowledge very early in life, publishing his first paper—On the Existence of Chlorine in the Native Peroxide of Manganese—in 1828. This was followed by other contributions. He was appointed Professor of Natural Philosophy to the Dublin Society in 1834, and devoted himself to original research in chemistry. He was afterward head of the Museum of Irish Industry, and first President of Queen's College, Cork. He was author of a large and important work on the Industrial Resources of Ireland. He received many honors, in recognition of his scientific labors, from the Government and from learned societies.

M. EDMOND HÉBERT, an eminent French geologist, died April 4th, in the seventy-eighth year of his age. He was made Professor of Geology at the Sorbonne in 1857, and in the same year was chosen to succeed Charles Sainte-Claire Deville in the Section of Mineralogy in the Academy of Sciences. He was author of many important geological memoirs. His principal works were on the Oscillations of the Crust of the Earth, and the Ancient Seas and their Shores in the Paris Basin. He was an exponent of the doctrine of the adequacy of existing causes to explain geological phenomena.

PROF. VON QUENSTEDT, of Tübingen, one of the most famous of German paleontologists, and a mineralogist, too, died December 21st. He was author of works on the Jura, and one on petrifactions or fossils. He was distinguished for his profound knowledge of the Lias of Würtemberg and its fossils.

DR. PAUL NIEMEYER, Sanitary Counselor, and author of works relating to hygiene, died in Berlin, on the 25th of February, in the fifty-sixth year of his age. Several of his books, including his Doctrine of Health, Advice to Mothers, and Sunday Rest, had wide circulation, and were translated into other languages. He assisted Miss Nightingale in the revision of her Notes on Nursing.

M. CHARLES M. V. MONTIGNY, a Belgian astronomer and meteorologist, died near Brussels, March 16th, aged about seventy years. He was honorary professor in the Royal Athenæum of Brussels, and a member of the Belgian Academy of Science; and had been connected with the observatory as a correspondent since 1879. His most important researches were on the scintillation of the stars, for which he invented an instrument called the scintillometer, which he observed industriously for several years, and which led him to new views concerning refraction; the relation of the height of the barometrical column and the pressure of the wind; the velocity of the wind, and its inclination. In the last research he is believed to have been the first who occupied himself with the subject.

DR. GEORGE THURBER, an eminent botanist and writer on horticultural subjects, died in Passaic, N. J., April 2d, in the seventieth year of his age. He was born in Providence, R. I., in 1821. Studying pharmacy, he became interested in botany. In 1850, in connection with the United States and Mexico Boundary Survey, he explored the botany of the country between the Gulf of Mexico and the Pacific Ocean. The results of this study were published by Asa Gray in Plantæ Novæ Thurberianæ. He was from 1859 to 1863 Professor of Botany and Horticulture in the Agricultural College of Michigan. As editor of the American Agriculturist, from 1863 till 1885, he made it the ablest and most influential journal of its class. He published, in 1859, American Weeds and Useful Plants—an enlargement of Darlington's Agricultural Botany; contributed on botanical subjects to Appletons' Cyclopædia; and made a thorough, systematic study of grasses.